

# Emotion-oriented AOM: A Case study

Syazwanie Filzah binti Zulkifli  
Faculty of Computer Science and  
Information Technology,  
Universiti Malaysia Sarawak,  
Kota Samarahan, Malaysia  
[waniefilzah@yahoo.com](mailto:waniefilzah@yahoo.com)

Cheah Wai Shiang  
Faculty of Computer Science and  
Information Technology, Universiti  
Malaysia Sarawak,  
Kota Samarahan, Malaysia  
[wscheah@unimas.my](mailto:wscheah@unimas.my)

Nurfauza binti Jali  
Faculty of Computer Science and  
Information Technology, Universiti  
Malaysia Sarawak,  
Kota Samarahan, Malaysia  
[jnurfauza@unimas.my](mailto:jnurfauza@unimas.my)

**Abstract**—A successful application requires the software engineer to take into account the users feeling in the modeling process. For example, how to elicitate the emotion of “interest”? How to transform the emotion of “interest into design and implementation?”. Previous research claims that there was existing gap to fulfilling user emotional requirement throughout the software development life cycle. By adding emotion thinking, it is possible to avoid application failure and rejection. From the study, the emerging of Agent Oriented Modeling (AOM) is to design the modeling emotion expression since user emotions are critical in determining whether or not an application will be accepted. AOM is agent-oriented methodology that is compliance with model driven architecture and uses the concept of agent in all stages of its process through modeling steps. Unlike Unified Modeling Language (UML), which is more suitable for modeling functional requirements but not for dealing with the new emotional requirement. Thus, AOM is a better approach for dealing with human emotions. While AOM has been extended with emotion models, it still lacks the ability to systematically elicit, analyse, develop, and implement emotion-oriented applications. This study extends the AOM with emotion element across nearly all AOM models. Thus, by having a systematically set of models for emotion-oriented application, it can serve as a guide to design, redesign, and discuss the emotion elements among the software development team in emotion-oriented application.

**Keywords**—emotion, methodology, modeling, agent-oriented modeling, quiz

## I. INTRODUCTION

Emotions are intense feelings directed at someone, something, or nothing at all [1]. An emotional-oriented application, on the other hand, is one that takes into account the emotional or user feelings in the development of the application[2]. Online quizzes and Massive Open Online Courses (MOOCs) are two examples of emotion-oriented applications that may be used to make learning more engaging and interesting for students[3].

Quiz MASTer is a game-based educational learning system that is integrated with an intelligent software agent to provide appropriate feedback to the learner [4]. Meanwhile, emotion-based Quiz MASTer is a quiz application that uses a virtual character to comfort students throughout quizzes by using various emotion elements and feedback [3]. The aim of the study is to reduce the complexity in developing emotion-oriented application. Considering user emotions throughout the development process can lead to the discovery of a new

requirement [5], the ability to improve user experience [5], the acceptance of an application[5], and the decrease of the failure of a rejected application[2]. Work has been done to capture user feeling and emotion and transform into software development happened in [2],[5],[7],[8],[9],[10],[11],[16].

One of the reasons for the application's failure and rejection is that the emotional needs of users were overlooked or given little consideration during software development [2]. Software designers typically design functional and non-functional requirements based on their understanding [2]. For example, a photo sharing online application will not be used if individuals do not feel involved or in contact with their friends and family when using the system [5]. Furthermore, individuals play video games to have fun, to be excited, to be scared, and to avoid boredom[6]. Rather of focusing just on the system, addressing their emotional requirements as the third class of aim in AOM might improve the emotional reaction of users to software products. Recent research has not extensively explored how to incorporate emotional goals into the software development life cycle [2].

There has been little research into adding user emotional expectations into the software development life cycle. Without proper guidance on how to include user emotional goals into the software development life cycle, software developers tend to disregard these goals as the project progresses[2]. So far, no technique has been developed that allows us to elicit user emotional goals [2]. Emotional thinking must be integrated throughout the development process[2]. As a result, emotional goals should be given the same importance as functional and quality goals[2].

However, how to elicitate user emotion? How to design and implement it through Quiz MASTer application? In our study, we addressed this existing gap introduces a systematic way to model an emotion-oriented application emotion capturing, analysis and design using the Agent oriented Modeling (AOM). AOM is agent-oriented methodology that is compliance with model driven architecture and uses the concept of agent in all stages of its process through modeling steps [14]. In turn, agent can be humans or artificial . AOM was introduced to provides an approach for modelling complex systems made up of humans, hardware, and software agents in a changing environment [14]. Unlike UML modelling, which is ideal for modelling functional requirements, UML is incapable of addressing human aspects such as emotions.

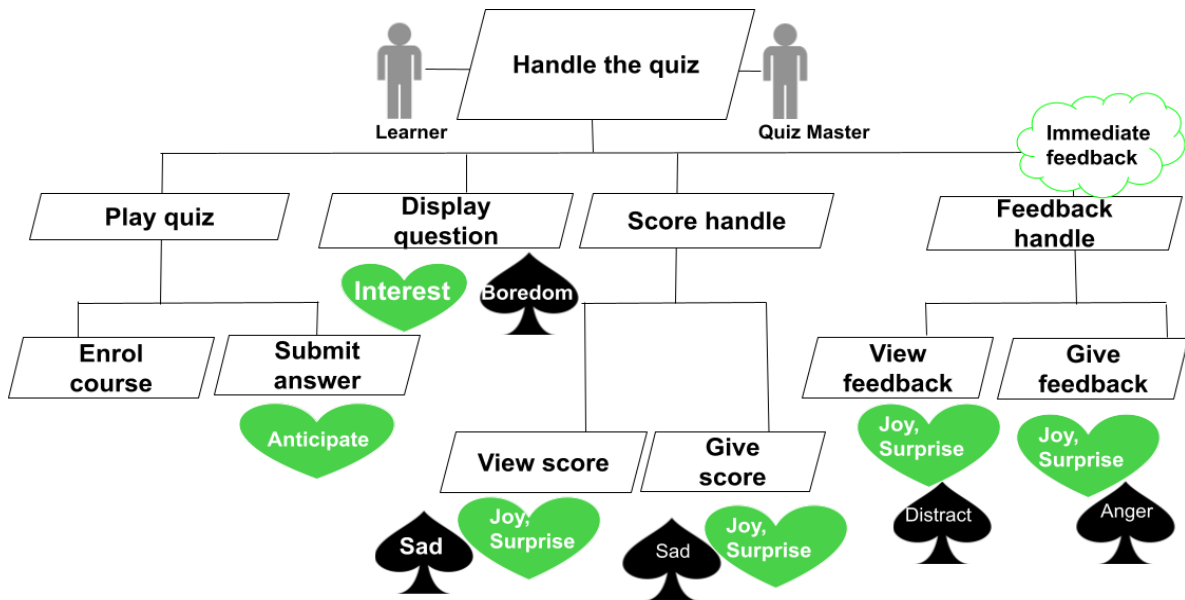


Fig. 1. Emotion-oriented goal model for Quiz MASTER

AOM is capable of capturing user feelings and transforming them into the design and development of emotion-oriented applications. The interaction diagram in AOM represents the interaction of agents (human or artificial) with the system [5]. In AOM, various agent models have been introduced [14]. These include emotion models [5], goal models, role models, organization models, domain models, agent and acquaintance models, interaction models, knowledge models, scenarios model and behavior models [14].

In our study, we addressed this existing gap by proposing methods to elicit requirements with HOMER; emotion-oriented goal model, emotion-oriented role model, emotion-oriented Tropos goal model, emotion-oriented goal model for quiz master to handle joy expression, emotion-oriented domain model for Quiz MASTER application, emotion-oriented scenario model, interaction model and behavior model and emotion-oriented knowledge model. To illustrate the usability of emotion-oriented AOM, the confirmatory case study, Quiz MASTER, was used as an example to explore the use of AOM in the design of an emotion-oriented application. The Quiz MASTER is based on a TV quiz game show in which the game host asks questions to a group of competing competitors. In Quiz MASTER application, the contestants are replaced by students, and the presenter is replaced by an intelligent software agent that delivers relevant feedback based on the responses of the students [4].

The game has two agents: (1) a host agent and (2) a crowd agent. The host agent will greet the student with his or her attention fixed on the student. During the game, the player will be asked a question and will have one minute to respond. If the kids deliver the correct response, the host agent will congratulate the student as the audience cheers and claps. If the student responds incorrectly, the host agent will wish the student luck on the following question as the audience expresses sympathy for the student with squirming sounds and animations. Meanwhile, once player have completed the set of questions, one point will be awarded for each correct answer. The game will be won by the student with the highest score. The study starts with a case study and then moves on to agent models that take emotion into account.

## II. METHODOLOGY FOR EMOTION-ORIENTED APPLICATION

### A. Overview of extended AOM research methodology for emotion-oriented application

The four layers will be addressed in this research methodology. These layers are the requirement elicitation layer, the motivation Layer [14], the system design layer [14], and the development layer [14]. The requirement elicitation layer involves eliciting requirements with Human Oriented Method for Eliciting (HOMER). These elicitation answers are mapped into extended goal model, extended role model, tropos goal model and domain model in the motivation layers.

The motivation layer is used to understand what people want and desire, the problem to be solved, and the overall purpose, goals, and requirements of the socio-technical system among stakeholders. Afterwards, the motivation layers are mapped into scenario, interaction, and behavior and knowledge models in the design layers. The design layer, on the other hand, covers the design element of the interactive application. Finally, these design layers will be transformed into programming language.

### B. Step 1: Elicit requirements with HOMER

The focus of emotion modelling is as following. The step involves is to elicit requirement with Human Oriented Method for Eliciting (HOMER). HOMER is an elicitation technique that uses elicitation questions to elicit the requirements of stakeholders such as functional, non-functional and emotional requirements. These include interview session and specify the AOM through HOMER answers [15]. From HOMER elicited answer in the requirement elicitation layer, the modeller will proceed with the modelling process at the Motivation layer.

### C. Step 2: Emotion-oriented goal model for Quiz MASTER

Figure 1 presents the emotion-oriented goal model for Quiz MASTER. Emotion models are a new requirement or goal in AOM that are used to capture and model the emotion-oriented applications. There are two kinds of emotional goals.

The emotional goal and emotional threat are examples of this. Emotional goals are positive emotions represented as a heart shape to reflect the emotional need of what the user wants to feel in the applications [5]. The positive emotion, such as feeling joy, trust, engaged, interest, serenity, and surprise.

Emotional threat is a negative emotion that describes an emotion that the user does not want or that must be avoided in the application[5]. Boredom, grief, distraction, fear, rage, and frustration are examples of negative or unpleasant emotions. Emotional threat is represented by spades. In the context of Quiz MASter, Handle Quiz is the main functional goal. In order to achieve the main functional goal, several purposes of the system has been translated into functional goal or sub-goals. These include the play quiz, display question, score handle and feedback handle. Learners and quiz master are responsible to achieve the main functional goal of handle the quiz.

To play the quiz, the learner must enrol the course and submit the answer in the quiz. Once the learner has submitted an answer, the learner wants to anticipate the answer. They like imagining and planning what will happen in the next question after they have submitted their answer. The quiz master are responsible to achieve the functional goal of the Display Question. The quiz master will display the question after learner enrol the course. Meanwhile, the Quiz master wants to feel interest during display the question to the Learner. Quiz master does not want to feel boredom during display the question to the Learner. Boredom was found associated with poor learning environment[13]. In other words, boredom was defined as the anxious due to lack of interest [13].

Boredom may negatively impact on them, causing poor achievements [12]. Thus, boredom is considered as the negative feeling that the quiz master does not want to feel particularly during give the question. After the learner answered the question, the quiz master will give score and give feedback to the learner.

Score handle consists the sub goals of view score and give score. If the learner provided the correct answer, the high score would be displayed to the learner, and vice versa. The learner wants to feel joy when viewing a high score and surprise when viewing a low score. When viewing the low score, the learner does not want to feel sad. The same is relevant for quiz masters; they want to feel joy when they provide a high score to a learner and surprise when they give a low score to a learner. They do not want to be sad when the score is delivered.

Feedback handle does consist the sub goals of View feedback and Give feedback. The functional goal Feedback handle is associated with the quality goal "immediate feedback. The immediate feedback can improve the understanding of the learner[17]. If the learner submitted the correct answer, the quiz master will give the positive feedback. When viewing positive feedback, the learner wants to feel joy, and when viewing negative feedback, the learner wants to be surprised and not distracted. Any bad emotion that the user does not want to feel, such as boredom, sadness, distraction, or anger, was regarded as an emotional threat [12].

The role model elaborates the roles that are involved in the application [9]. Role model will be briefly described in the following phase.

#### D. Step 3: Emotion-oriented role model for learner

A role model has been extended with lists of the responsibilities of the role with the emotional goal and threat. For example, the learner wants to feel joy when view high score. The learner wants to feel surprise when view low score and does not want to feel sad. The learner wants to feel joy when view positive feedback. The learner wants to feel surprise when view negative feedback and not feel distract. Table 1 presents the emotion-oriented role model for the learner.

Tropos goal model will be briefly described in the following step on how the interaction of the role can influence the sensation of another individual role.

TABLE I. THE EMOTION-ORIENTED ROLE MODEL FOR LEARNER

Role	Item	
Role Name	Learner	
Description	A learner who want to play the quiz	
Responsibilities	Emotional goal	Emotional threat
Enrol course	None	None
Submit answer	Anticipate	None
View high score	Joy	None
View low score	Surprise	Sad
View positive feedback	Joy	None
View negative feedback	Surprise	Distract
Constraints	A learner must answer all question A learner must score more than 16 mark to receive award	

#### E. Step 4: Emotion-oriented Tropos goal model

Tropos goal aim model is used in this stage to model in detail how the interaction of the role can influence the feeling of another individual role. A dependency can be described as when one actor (the depender) depends on another actor (the dependee) for gain some dependum [14]. If the dependee fails to deliver the dependum, the depender would be unable to achieve its goals on its own or not as easily. Since emotion is interactive mechanism, there are need model that can model interaction of emotion element.

Figure 2 depicts the emotion-oriented tropos goal model with an emphasis on emotion. The learner is depending on the quiz master to display the question. The quiz master is responsible for displaying the question to the learner. When displaying the question, the quiz master wants the learner to be interested and does not want the student to be bored. The quiz master is counting on the student to submit an answer. When submitting the response, the learner wishes to feel anticipation. The quiz master understands that the student wants to feel a sense of anticipation as they submit their response. Meanwhile, learners rely on the quiz master to assign a score. Learners depend on the quiz master to give feedback to the learner. The learner's emotion is influenced by the feedback they received from the quiz master.

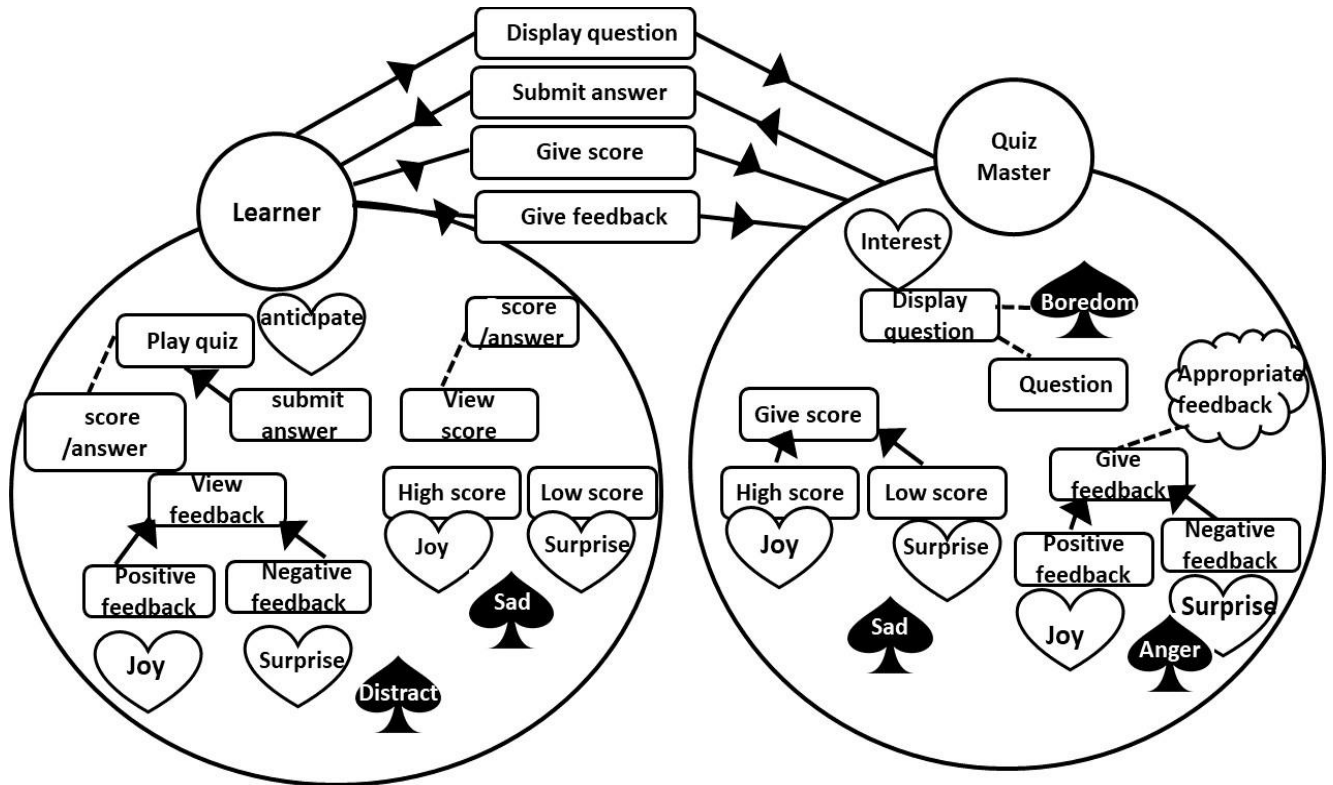


Fig. 2. Emotion-oriented tropos goal model for Quiz MASTER

#### F. Step 5: Emotion-oriented domain model

Once the emotion associated with goal dependency has been identified, we can proceed to identify the method for dealing with the emotion as well as the knowledge entities that will be influenced by emotion. This is accomplished using the goal model and the domain model. Figure 3 presents the emotion-oriented domain model for Quiz MASTER application. It does show the domain entities like course, question, answer, score/answer and feedback for studying Quiz MASTER behavior. When learner enrol the course, the course will affect the question. Afterwards, the quiz master will display the question that allow the quiz master to feel interest and not feel boredom. Once the learner submit answer, the learner wants to feel anticipate when waiting for the answer. The quiz master will receive the answer and affect the score and lead to the feedback.

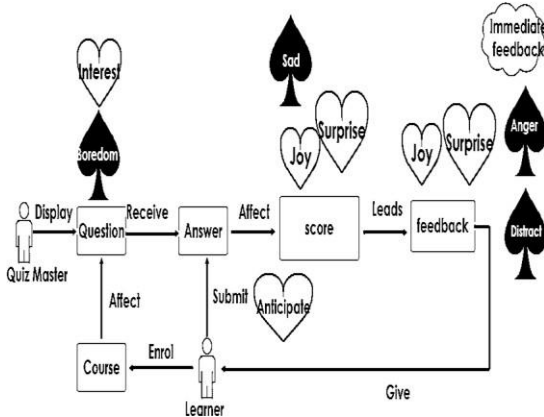


Fig. 3. Emotion-oriented domain model for Quiz MASTER

#### G. Step 6 : The emotion-oriented goal model for quiz master to handle joy expression

This step involved identifying ways for handling emotions when providing positive and negative feedback using the goal model and domain model. In this paper, we design virtual agent, the quiz master that can handle its emotion through verbal, nonverbal expression, background music, visual engagement, and reward forms. Figure 4 presents the emotion-oriented goal model for the quiz master to *Handle joy expression*. This step involves identify strategies of handling the emotion when give positive and negative feedback through goal model and domain model. The strategies that involve are *Give high score*, *Express smile expression*, *Show thumb up*, *Play clap sound*, *Show motivation pictures*, *Bright color background* and *Unlock new level*.

#### H. Step 7: The emotion-oriented scenario model, interaction model, behavior model and knowledge model..

After having decided the agent types and modeling the domain entity is emotion modeling, the scenario, interaction and behavior model will be modeled in this step. Table 2 presents the Scenario 1 for achieving handle the quiz. This involved modelling the design aspect of emotion oriented application. Figure 5 present the interaction model of learner at the beginning of Quiz MASTER. When a learner enrols in a course in the Quiz MASTER app, the quiz master will display greetings. "Greetings! This is where you ask the learner questions". The quiz master will next provide the question to the learner, and learner will want to feel excited when they submit their answer.

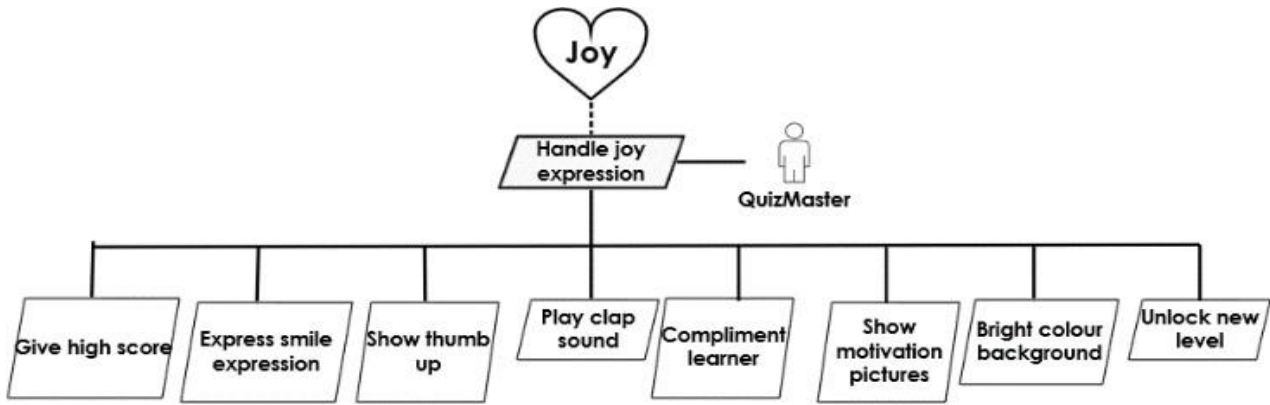


Fig. 4. Emotion-oriented goal model to handle joy expression

TABLE II. THE EMOTION-ORIENTED ROLE MODEL FOR LEARNER

Scenario 1				
Goal	Handle the quiz			
Initiator	Learner			
Trigger	The learner enrol the course			
Failure	The learner stop the quiz			
Description				
Condition	Step	Activity	Agent types/role	Emotional goal and threat
	1	Enrol course	Learner	None
	2	Display greeting	Quiz Master	None
	3	Display question	Quiz Master	Interest, Boredom
	4	Submit answer	Learner	Anticipate
	5	View high score and positive feedback	Learner	Joy
	6	View low score and negative feedback	Learner	Surprise, Sad, Distract
	7	Give high score and positive feedback (Scenario 2)	Quiz Master	Joy
	8	Give low score and negative feedback (Scenario 3)	Quiz Master	Surprise, Sad, Anger

They are hoping for the good news once submits the answer learner answers the correct answer. The learner initiates its own feeling of anticipate by triggering rule *R1* to initiate activity by *submit correct answer*. *R1* leads to epistemic CREATE action of new knowledge of *answer*. On the other hand, the quiz master wants to feel joy when *give score 2 marks* to the learner. Rule *R2* is triggered after display score and this lead the initiate of rule *R3* within the feedback activity type and CREATE action of new knowledge of feedback. Within this activity type it triggers the feeling joy of the quiz master and the learner.

These include show smile expression, show thumb up, play clap sound, positive feedback, show motivation pictures and

display bright color. Rule *R4* is triggered after displaying bright color activity type is done. Rule *R4* has one condition: learner receives the final total score with more than 16. The learner needs to satisfy the rule *R4* before can unlock new level. If the learner receives less than 16, an activity of type Return home is performed and the enclosing activity of type Feedback finishes.

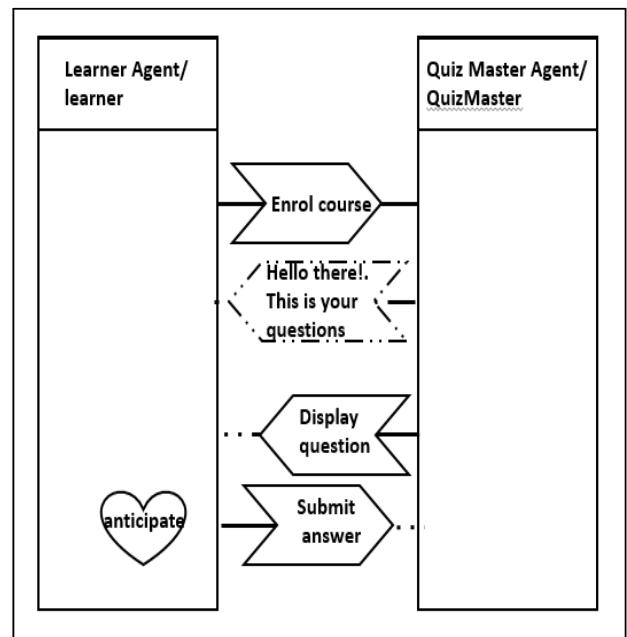


Fig. 5. Emotion-oriented interaction model of learner in the beginning of Quiz MASTER

Figure 6 presents the behavior model of *quiz master* if the learner answers the correct answer. The learner initiates its own feeling of anticipate by triggering rule *R1* to initiate activity by *submit correct answer*. *R1* leads to epistemic CREATE action of new knowledge of *answer*. On the other hand, the quiz master wants to feel joy when *give score 2 marks* to the learner. Rule *R2* is triggered after display score and this lead the initiate of rule *R3* within the feedback activity type and CREATE action of new knowledge of feedback. Within this activity type it triggers the feeling joy of the quiz master and the learner. These include show smile expression, show thumb up, play clap sound, positive

feedback, show motivation pictures and display bright color. Rule R4 is triggered after displaying bright color activity type is done. Rule R4 has one condition: learner receives the final total score with more than 16. The learner needs to satisfy the rule R4 before can unlock new level. If the learner receives less than 16, an activity of type Return home is performed and the enclosing activity of type Feedback finishes.

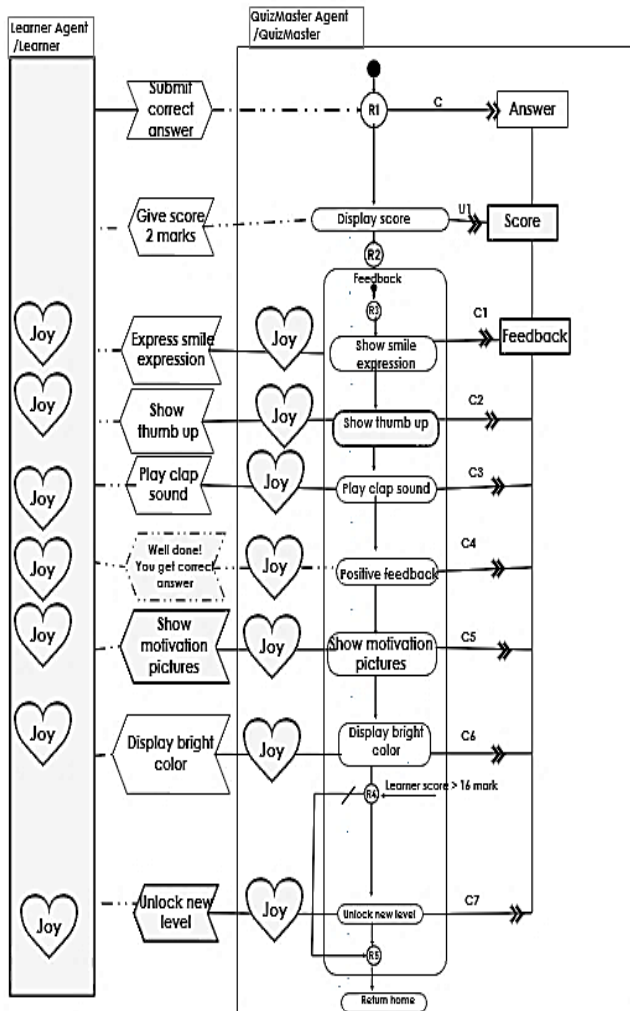


Fig. 6. Emotion-oriented behavior model for correct answer

Figure 7 present the knowledge model for Quiz MASTer application. The course, question, answer, score and feedback are public knowledge because (a) Course register by learner agent is the same source created by the quiz master agent during play the quiz, (b) question given by the quiz master agent is the same question transferred to the Learner Agent, (c) answer given by the quiz master Agent is the same answer transferred to the Learner Agent, and finally (d) score given by the quiz master Agent is the same when given to the Learner Agent.

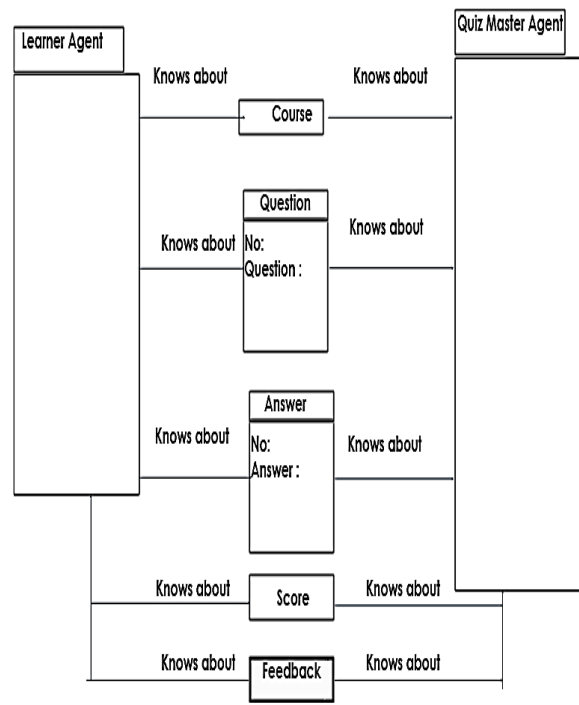


Fig. 7. Knowledge model of the Quiz MASTer

1. Step 8 : Interface of the Quiz MASTer application during the feedback

Figure 8 shows the Quiz MASTer application's interface as it begins to answer the wrong question. When a learner sees a low score, learner wants to be shocked rather than unhappy. When a student earns a low score, the quiz master does not want to be disappointed; rather, the quiz master wants to be surprised. The strategies involved are as follows: Give no score marks, make an amazed or surprised face, the quiz master will mention the learner's name to encourage the student, show do not give up photos, and give the answer message.

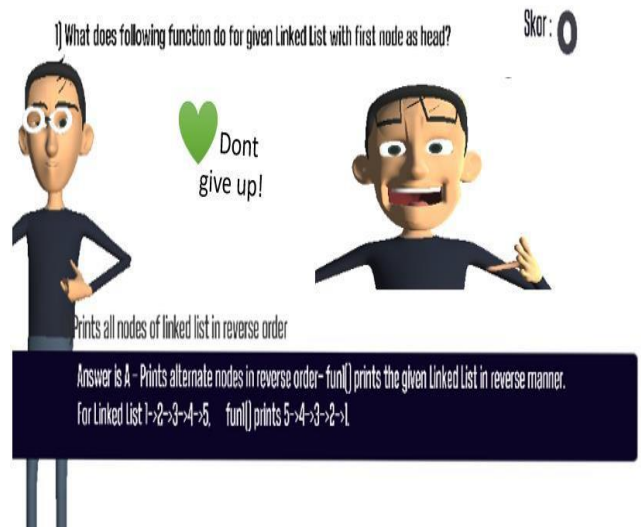


Fig. 8. Interface of the Quiz MASTer application during the feedback

Figure 9 shows the Quiz MASTer application's interface as it begins to answer the correct question. When a learner sees a high score, learner wants to be joy and The strategies involved are as follows: received a score of 20 out of 100, a positive message, a smiling expression, a clap sound effect, a bright colour, a motivation picture, and the ability to go to the next level.

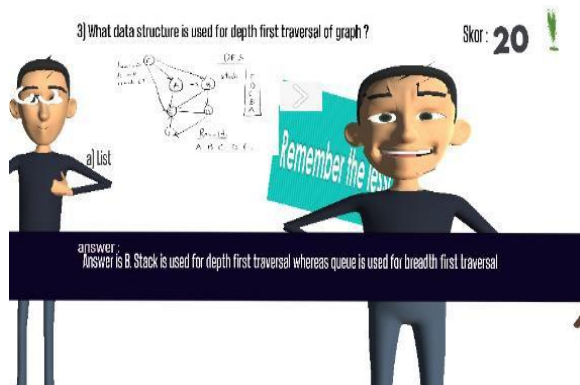


Fig. 9. Interface of the Quiz MASTer to answer correct answer.

### III. LESSON LEARNT

In this paper, we have AOM introduced to model a socio technical system in which it models interaction between human and system. Unlike the UML modeling is suitable to model the functional requirement, UML is lacking to handle the human aspect. Understanding the user feeling is very hard and abstract. With the extended AOM, it is able to capture user feeling and transform into the design and development of emotion-oriented application. An informal discussion with ten 10 postgraduate students in using extended AOM for emotion-oriented application has shown that some of them really like the idea of using new notation of emotion model in goal model and interaction model. The emotion models can drive the conversation and communication of user feeling. During the discussion, students suggest should include pleased, surprise, excited and cheerful as positive emotions. Also, they suggested to use sceptical, furious, confuse, sarcasm and bored as the negative emotion through all other models in AOM.

### IV. CONCLUSION

User emotional expectation is a major predictor of application acceptance. However, there has been minimal research on incorporating user emotional expectations into the software development life cycle. This research bridges the gap in fulfilling user emotional requirements by expanding on previous works that claim AOM can model emotion-oriented applications. We addressed this existing gap in our study by proposing methods to elicit requirements with HOMER; emotion-oriented goal model, emotion-oriented role model, emotion-oriented Tropos goal model, emotion-oriented domain model for Quiz MASTer application, emotion-oriented goal model for quiz master to handle joy expression, emotion-oriented scenario model, interaction model and behavior model and emotion-oriented knowledge model. The discovery of demonstrates that extended AOM is useful to designers in order to systematically model an emotion-oriented application using the proposed method, which requires more validation and verification in future works. reflections and contribution

## V. ACKNOWLEDGMENT (Heading 5)

My sincere special gratitude to Professor Kuldar Taveter, Dr Cheah Wai Shiang, and the RESOSY 2021 committee for their assistance with this research.

### REFERENCES

- [1] See N. H. Frijda, "Moods, Emotion Episodes and Emotions," in M. Lewis and J. M. Haviland (eds.), *Handbook of Emotions* (New York: Guilford Press, 1993), pp. 381–403.
- [2] Kissoon Curumsing, M. (2017). *Emotion-Oriented Requirements Engineering*. (unpublished phd's thesis). Swinburne University of Technology, Kuching, Sarawak.
- [3] Wai, S. Y., Shiang, C. W., Zulkifli, S. F., Jali, N. B., & Khairuddin, M. A. (2019). Requirement engineering meets emotion: A case study of Quiz MASTer. *International Journal of Advanced Science and Technology*, 281(2), 215–222.
- [4] Leung, S., Virwaney, S., Lin, F., Armstrong, A. & Dubbelboer, A. (2013). TSI-enhanced pedagogical agents to engage learners in virtual worlds. *International Journal of Distance Education Technologies*, 11(1), 1–13.
- [5] Lopez-Lorca, A. A., Miller, T., Pedell, S., Sterling, L., & Kissoon Curumsing, M. (2014). *Modeling Emotional Requirements*. <http://people.eng.unimelb.edu.au/tmiller/pubs/mo-dellingemotional-requirements.pdf>.
- [6] Marshall, J. (2018). Agent-Based Modeling of Emotional Goals in Digital Media Design Projects. In S. Goschnick (Ed.), *Innovative Methods, User-Friendly Tools, Coding, and Design Approaches in People-Oriented Programming* (pp. 262–284). IGI Global.
- [7] Sherkat, M., Mendoza, A., Miller, T., & Burrows, R. (2018). *Emotional Attachment Framework for People-Oriented Software*, 1–34.
- [8] Curumsing D., Fernando, M. K., Abdelrazek, M., Vasa, R., Mouzakis, K., & Grundy, J. (2019). Emotion-oriented requirements engineering: A case study in developing a smart home system for the elderly. *Journal of Systems and Software*, 147, 215–229.
- [9] Miller, T., Pedell, S., Lopez-Lorca, A. A., Mendoza, A., Sterling, L., & Keirnan, A. (2015). Emotion-led modeling for people-oriented requirements engineering: The case study of emergency systems. *Journal of Systems and Software*, 105, 54–71.
- [10] Sherkat, M., Mendoza, A., Miller, T., & Burrows, R. (2018). *Emotional Attachment Framework for People-Oriented Software*, 1–34.
- [11] Sterling, L., Lopez-Lorca, A., & Kissoon-Curumsing, M. (2018). Adding emotions to models in a viewpoint modeling framework from agent-oriented software engineering: A case study with emergency alarms. In Goschnick, S. (Eds.), *Innovative Methods, User-Friendly Tools, Coding, and Design Approaches in People-Oriented Programming* (324–367). IGI Global.
- [12] D'Errico, F., Paciello, M., & Cerniglia, L. (2016). When emotions enhance students' engagement in e-learning processes. *Journal of e-Learning and Knowledge Society*, 12(4).
- [13] Baker, R. S. J. D., D'Mello, S. K., Rodrigo, M. M. T., & Graesser, A. C. (2010). 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. *International Journal of Human-Computer Studies*, 68(4), 223–241.
- [14] Sterling, L., Taveter, K. (2009). *The Art of Agent-Oriented Modeling*. London, England: The MIT Press.
- [15] Cheah W. S., Sterling L., & Taveter K. (2012). Task Knowledge Patterns Reuse in Multi-Agent Systems Development. In: Desai N., Liu A., Winikoff M. (Eds.), *Principles and Practice of Multi-Agent Systems* (pp. 459–474). Springer.
- [16] Lorca, A. L., Burrows, R., & Sterling, L. (2018, August). Teaching motivational models in agile requirements engineering. In *2018 IEEE 8th International Workshop on Requirements Engineering Education and Training (REET)* (pp. 30–39). IEEE.
- [17] Gamage, S. H., Ayres, J. R., Behrend, M. B., & Smith, E. J. (2019). Optimising Moodle quizzes for online assessments. *International Journal of STEM Education*, 6, 27.