A Simulator's Specifications for Studying Students' Engagement in a Classroom

Latha Subramainan[1], Moamin A Mahmoud[1], Mohd Sharifuddin Ahmad[1],

Mohd Zaliman Mohd Yusoff[2]

[1] College of Computer Science and Information Technology,
Universiti Tenaga Nasional, Kajang, Selangor, Malaysia.
[2] Business Development Unit, TNB Integrated Learning Solution Sdn Bhd.

`latha0522@gmail.com,{moamin, sharif}@uniten.edu.my,`
`zaliman.yusoff@tnb.com.my`

Abstract. In this paper, we highlight the issues of poor students' engagement in classrooms and identify the attributes for the environmental settings of a proposed simulator to study the problem of students' poor engagement from the students' emotional demotion using agent-based social simulation concepts. The environmental settings of the simulation is classified into environmental factors and emotional factors. The environmental factors consist of a number of students, class session, class duration, type of subject, and year of study, while the emotional factors include the negative emotional states of student (e.g. anger, anxiety or boredom) and the emotional states of lecturers. In this simulation, a lecturer, who might have ideas on new strategies based on their experience, is able to insert a new strategy using a proposed Strategy Specification Settings Interface.

Keywords: Students' Engagement; Emotional Engagement; Agent-Based Emotions; Agent-Based Social Simulator

1 Introduction

Researchers focus on students' engagement in classrooms as a key to address issues such as low academic performance, high dropout rates, boredom and disaffection [1]. The students' engagement concept is significantly useful in predicting students' academic performance [2]. Researchers use numerous indicators to measure engagement that includes self-report, attendance rates, teacher ratings, interviews, observations, cross-cultural data and assessments grades [3, 22, 23]. However, the affective disposition of lecturers and students has not been comprehensively studied to understand its effects on students' engagement in classrooms.

In this paper, we aim to identify the symptoms of students' negative emotional states and a possible strategy to improve the students' engagement in a classroom based on the negative emotional states of anger, anxiety and boredom. Previous

researchers aim to improve students' engagement randomly and not limited to cater any specific emotions. We also believe lecturers in a class are always able to dynamically change their teaching styles or strategies based on emotional feedback portrayed by students [7].

This paper is an extension to our work in studying and enhancing students' engagement strategies using an agent-based emotion model [8, 21]. In our earlier research, we presented a conceptual agent-based emotion model animated by an agent-based social simulation [Ref]. We use an agent platform for animating a classroom environment in running multiple settings and obtaining results that are more accurate. The rudimentary theory of this study is based on four main elements; the selected strategy to control engagement, the engagement level of students, the emotional state of a lecturer and the emotional states of students in a classroom. Hence, in this paper we highlight factors influencing lecturers' emotions and students' negative emotional states that impact on the students' engagement in a classroom. We also discuss the potential factors influencing strategies to improve student engagement.

2   Related Works

Students' engagement serves as a protective factor against students dropout and involvement in perilous activities [9]. But students' emotional engagement has received little attention due to its lack of conceptual clarity [4, 9]. According to Kort et al. [10], "students who are anxious, angry, or depressed don't learn; people who are caught in these states do not take in information efficiently or deal with it well". Therefore, the importance of emotion in classroom teaching cannot and should not be taken lightly. Pekrun et al. [11], identify a variety of emotions experienced by lecturers and students, including joy, enthusiasm, hope, relief, pride, gratitude, admiration, sadness, anger, anxiety, hopelessness, shame and guilt, disappointment, boredom, envy, disrespect, and surprise.

A lecturer could monitor a student's engagement level in a classroom via indirect indicators, for instance, the intensity of participation in classroom discussions, attendance, commitment to a given task, time spent on assessments, intensity of concentration during ongoing lessons and the motivation or interest shown on a particular course materials [20]. A recent study has shown that various factors could invoke lecturers' emotions depending on the context which the lecturer encounters, for instance, specific class, subject domain, and specific lesson [12]. However, lecturers usually report that students' behaviors, discipline and their interpersonal relations to their students as significant sources of their emotions. Studies suggest that enjoyment is the most prominent positive emotion and anger is the most frequently experienced negative emotion, lecturers experience while teaching [12]. Lecturers' emotions subsequently influence their instructional behaviors during lessons which could then impact on student academic outcomes and behaviors. Lack of engagement also indicates lecturers' emotions [11]. A recent research reports that lecturers' anger is triggered particularly if the "students' misbehaved or did not engage in the learning

process" [13]. Hagenauer et al. [13], argue that students' misbehavior in the classroom represents a threat to their instructional or management goals which is strongly related to negative emotions. Students' misbehavior, motivation and participation levels have been shown to be an important cause for negative emotional experiences in lecturers and one of the main sources for lecturers exhaustion and stress levels [14, 15]. Studies have indicated emotions are always involved in the learning process. Normally, students feel proud or pride about scoring good grades in assessments, anxious or frustrated when they are not able to understand the course materials, and may get angry with a lecturer who is uncaring and being unfair to them. They might also feel bored learning a topic which disinterest them. Anger and boredom are reported as occurring fairly frequently in a classroom [11]. In addition, boredom is reflected during lessons, anxiety and anger are usually experienced as fear of failure or anger at failure [16]. Both lecturers and students experience a total of six emotions in the classroom. They share a few common emotions such as enjoyment, pride, anger, anxiety and boredom in the classroom. However, in our study, we focus on negative emotions of students, which are anger, anxiety and boredom. These emotions selection is based on two reasons: (a) it occurs frequently in a classroom [10] and (b) it is based on the control-value theory of achievement [14]. Only negative emotions can trigger a lecturer to change their teaching strategy to improve students' emotional state which then subsequently improve student engagement in a classroom. If positive emotion such as enjoyment occurs among the student and keeps the student engaged throughout the lesson, then the lecturer can maintain the strategy.

An agent-based social simulation (ABSS) is a method to model systems that comprise of individual, autonomous, cooperating agents [12]. This method can be used to model human behaviors and their effects to others. This method has enjoyed widespread use in emergency evacuations, car pooling and disaster response. One way of characterizing the research area of Agent-Based Social Simulation (ABSS) is that it constitutes the intersection of three scientific fields, namely, agent-based computing, the social sciences, and computer simulation. ABSS is an ideal approach to simulate systems that comprise of autonomous and interacting agents. Generally, ABSS is used to examine a phenomenon and solve problems that are challenging for humans to study and provide solutions. It can be used in a variety of areas (e.g., computer games) to represent human societies. Moreover, artificial and natural occurrences can be represented in the simulation. The reason for doing computer simulations is usually to gain a deeper understanding of the phenomenon. Research have proven that ABSS is a powerful tool for modelling and understanding phenomena in various areas such as economics and trading, health care, urban planning and social events. However, according to recent research, even though autonomous agents have been popular for decades, they are still in the early phases of implementations [3].

3   A Proposed Agent-Based Emotion Framework

Intelligent software agents have been widely used in distributed artificial intelligence and due to their autonomous, self-interested, rational abilities [24, 25, 26, 27], and social abilities [28, 29, 30]. The preliminary framework of this proposal is based on four main elements in a classroom; the selected strategy to control engagement, the engagement level of students, the emotional state of a lecturer and the emotional states of students. The process starts by selecting a strategy   and applying it to the students, which influences the students' emotional state. By
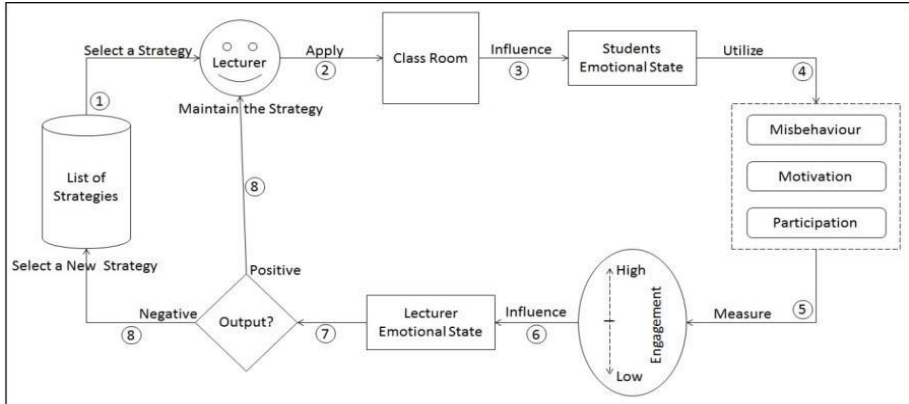
analyzing three variables, students' misbehaviors, motivation and participation, the engagement level of students can be measured. The result of engagement measurement positively or negatively influences the lecturer's emotion. If negatively, the lecturer change to another strategy that would trigger the students' emotion and eventually improve engagement. The lecturer again measures the engagement level and decide whether to apply another strategy or maintain the existing one. Figure 1 below illustrates the framework.

Fig.1. The Proposed Framework [8]

As shown in Figure 1, the Lecturer Agent (A_L) selects (1) a strategy from the list of strategies stored in the tool. The A_L then applies (2) the strategy during classroom session which eventually influences (3) Students' Agents ($A_{ST}s$) emotional state. By utilizing (4) the factors misbehaviour, motivation and participation, the A_L measures (5) the engagement level. The level of engagement influences (6) the A_L emotional state either positively or negatively (7). Negative emotion triggers (8) the A_L to select a new strategy which subsequently influences the $A_{ST}s$ emotional states that would improve their engagement in the classroom. The Lecturer maintains (8) the strategy if positive emotion occurred. The process continues until the $A_{ST}s$ displays positive factors of behavior, motivation and participation. In this paper, we identify the factors that influence students' engagement where A_L is able to propose the most appropriate strategy to improve students' negative emotional state and subsequently improve students' engagement in a classroom.

4   Student Emotional Engagement Evaluation

Changes in the emotional state of a student influences the engagement level which then subsequently effect the emotional states of lecturer. For example, whenever students get bored during the lesson, they would start playing games, talking to each other, and cease to pay attention to the lesson, resulting in a drop in their engagement to class lesson. Consequently, we found that students' emotional engagement could be inferred via observing the factors of misbehavior, motivation and participation.

Table 1 shows students' engagement evaluation with possible indications of each engagement factor.

Table 1. Student Emotional Engagement Evaluation

Student Engagement Factors	Indications	Possible Emotional states of Students	Engagement Level	Possible Emotional
Misbehavior [12]	• Striking out • Verbally or physically aggressive • Spoken in a raised voice • Acting in abusive manner	Anger	Low	Anger
	• Playing video games • Get away from class	Boredom	Low	Anxiety
Motivation [15]	• Non-attentiveness • Daydreaming • Talking out of turn	Boredom	Low	Anxiety
Participation [32]	• Avoidance or refusal to participate • Inability to initiate conversations • Avoiding eye contact	Anxiety	Low	Boredom

In a qualitative study, teachers revealed that their emotions are influenced by various aspects include students' misbehavior and poor relationships with them [12]. Besides, highly motivated students are related to teachers' enjoyment and vice versa [15]. Teachers also prefer to work with students who achieve their success through effort and participation [32]. Apparently, low engagement level negatively influences the emotional state of a lecturer. Therefore, the lecturer needs to initiate a strategy to improve students' engagement in a classroom. A good strategy is important for a teaching process. According to the literature, common components that forms a strategy are students' interest, teaching materials, time and resources management, teachers' planning skills, teacher enthusiasm and classroom environment (e.g. number of students, time of day, duration of class, age and ability of the students) [16, 17, 18].

In our study, we emphasize on the class environment factors, such as the number of students (30 or 60 or 90). Size of a classroom affects the motivation of students to engage verbally in classroom [33]. For instance, if a full classroom of 60 students, then the students in the back would not be able to listen the lesson properly. Consequently, it cause boredom among the students and they would start misbehave and pay no attention to lesson. Other strategies would be suitable for small number of students. Some factors includes class session (e.g. morning, afternoon/evening), class duration (1 hour, 2 hours or more).

Type of subject (e.g. theoretical or conceptual) also influence a strategy. A study revealed, student participation in conceptual class is high when a teacher divide students into three to five in a group and delegating the work [34]. In [35], study has revealed that quality of effort increases as the year of study increases. Therefore, year of study (first year or third year) plays a role in influencing a strategy. Furthermore, emotional factors such as negative emotional states of students (e.g. anger, anxiety or boredom) also occur based on the effectiveness of a strategy. According to [36], students seeing that a teacher's teaching strategy mostly as the main source of their boredom. Only small number of students admit the reasons for their misbehavior. To sum up, we develop the simulator based on environment and emotional factors.

5   The Simulation Functions

The proposed simulator could be utilized by researchers and educationists to investigate the problem of students' engagement. A lecturer needs to key-in information of a class Environment Settings. The required information are Subject Name, No. of Students, Class Session, Class Duration,   Type of Subject, Year of Study and finally estimate the percentage of misbehavior, motivation and participation levels of students based on their last class session experience which eventually predict the students' emotional states . Next, the lecturer can select any initial strategy and test it for multiple times to observe the performance of students' engagement level.

A lecturer, who might have ideas on new strategies based on their teaching experience, is able to insert a new strategy using the Strategy Specification Settings Interface and use the Likert scale to appropriately assign the likeability of the strategy. To run the simulator, a lecturer/researcher/educationist needs to insert information of a particular class environment and the percentage of misbehavior, motivation and participation level based on observations on students' behavior from previous sessions, and select an initial strategy. Having run the simulator, the software agents captures the environment setting data and play scenario to test the effectiveness of the selected strategy. The successful rate of the strategy will be shown in percentages. For example, Positive Peer Review strategy effectiveness might be 40% suit for particular environment settings. The agent is also able to recommend other strategies that would netter suit the given environment setting.

6   Conclusion and Future Work

In this paper, we present the development of our work-in-progress about constructing a virtual classroom environment to study and enhance students' engagement strategies using an agent-based emotion model. We explore the environmental settings of students' emotional demotion for a proposed simulator investigating the problem of the students' poor engagement. We first presented an agent-based emotion framework to compute students' emotions towards their lecturer and to recommend the best possible strategy based on the negative emotions of students.

The environmental settings of the simulation is classified into the environmental and emotional factors based on the scope of this research. Environmental factors such as the number of students, class session, class duration, type of subject, year of study, and emotional factors such as negative emotional states of student (e.g. Anger, Anxiety or Boredom).In the future work, we shall create a virtual environment simulating a classroom dynamics based on the settings. Experts from the field of computer science and social studies will validate the simulation.

7   References

1. Fredricks, J. A., Filsecker, M., & Lawson, M. A. (2016). Student engagement, context, and adjustment: Addressing definitional, measurement, and methodological issues.
2. Salleh, A. M., Desa, M. M., & Tuit, R. M. (2013). The Relationship between the Learning Ecology System and Students' Engagement: A Case Study in Selangor. *Asian Social Science*, *9*(12), 110.
3. Fredricks, J. A., & McColskey, W. (2012). The measurement of student engagement: A comparative analysis of various methods and student self-report instruments. In *Handbook of research on student engagement* (pp. 763-782). Springer US.
4. Pekrun, R., Cusack, A., Murayama, K., Elliot, A. J., & Thomas, K. (2014). The power of anticipated feedback: Effects on students' achievement goals and achievement emotions. *Learning and Instruction*, *29*, 115-124.
5. Kazmi, A. (2010). Sleepwalking through Undergrad: Using Student Engagement as an Institutional Alarm Clock. *College Quarterly*, *13*(1), n1.
6. Castro, S., Granlund, M., & Almqvist, L. (2015). The relationship between classroom quality-related variables and engagement levels in Swedish preschool classrooms: a longitudinal study. *European Early Childhood Education Research Journal*, 1-14.
7. Kung-Keat, T., & Ng, J. (2016). Confused, bored, excited? An emotion based approach to the design of online learning systems. In *7th International Conference on University Learning and Teaching (InCULT 2014) Proceedings* (pp. 221-233). Springer Singapore.
8. Subramainan, L., Mahmoud, M. A., Ahmad, M. S., & Yusoff, M. Z. M. (2016, August). A conceptual emotion-based model to improve students engagement in a classroom using agent-based social simulation. In *User Science and Engineering (i-USEr), 2016 4th International Conference on* (pp. 149-154). IEEE.
9. Skinner, E., Furrer, C., Marchand, G., & Kindermann, T. (2008). Engagement and disaffection in the classroom: Part of a larger motivational dynamic?. *Journal of Educational Psychology*, *100*(4), 765.

10. Kort, B., Reilly, R., & Picard, R. W. (2001). An affective model of interplay between emotions and learning: Reengineering educational pedagogy-building a learning companion. In *Advanced Learning Technologies, 2001. Proceedings. IEEE International Conference on* (pp. 43-46). IEEE.

11. Pekrun, R., Goetz, T., Frenzel, A. C., Barchfeld, P., & Perry, R. P. (2011). Measuring emotions in students' learning and performance: The Achievement Emotions Questionnaire (AEQ). *Contemporary educational psychology*, *36*(1), 36-48.

12. Frenzel, A. C., Becker-Kurz, B., Pekrun, R., & Goetz, T. (2015). Teaching this class drives me nuts!-Examining the person and context specificity of teacher emotions. *PloS one*, *10*(6), e0129630.

13. Hagenauer, G., Hascher, T., & Volet, S. E. (2015). Teacher emotions in the classroom: associations with students' engagement, classroom discipline and the interpersonal teacher-student relationship. *European journal of psychology of education*, *30*(4), 385-403.

14. Pekrun, R., & Linnenbrink-Garcia, L. (2014). Introduction to emotions in education. *International handbook of emotions in education*, 1-10.

15. Goetz, T., Frenzel, A. C., Pekrun, R., Hall, N. C., & Lüdtke, O. (2007). Between-and within-domain relations of students' academic emotions. *Journal of Educational Psychology*, *99*(4), 715.

16. Tsouloupas, C. N., Carson, R. L., Matthews, R., Grawitch, M. J., & Barber, L. K. (2010). Exploring the association between teachers' perceived student misbehaviour and emotional exhaustion: The importance of teacher efficacy beliefs and emotion regulation. *Educational Psychology*, *30*(2), 173-189.

17. Papa-Gusho, L., & Biçaku-Çekrezi, R. (2015). Factors that Affect Effective Planning Skills of the Teacher in the Classrooms. *Academic Journal of Interdisciplinary Studies*, *4*(3 S1), 560.

18. Bilash , O. (2009, May). Lesson Planning in the Language Classroom. Retrieved September 10, 2016, from http://sites.educ.ualberta.ca/staff/olenka.bilash-/Best%20of%20Bilash/lessonplanning.html

19. Making Effective Instructional Choices . (n.d.). Chapter (7), 133-145. Retrieved September 8, 2016, from http://teachingasleadership.org/sites/default/files/Related-Readings/IPD_Ch7_2011.pdf

20. Newmann, F. M. (1992). *Student engagement and achievement in American secondary schools*. Teachers College Press, 1234 Amsterdam Avenue, New York, NY 10027 (paperback: ISBN-0-8077-3182-X, $17.95; hardcover: ISBN-0-8077-3183-8).

21. Subramainan, L., Mahmoud, M. A., Ahmad, M. S., & Yusoff, M. Z. M. (2016). An Emotion-based Model for Improving Students' Engagement using Agent-based Social Simulator. *International Journal on Advanced Science, Engineering and Information Technology*, *6*(6).

22. Subramainan, L., Mahmoud, M. A., Ahmad, M. S., & Yusoff, M. Z. M. (2016, August). Evaluating students engagement in classrooms using agent-based social simulation. In *Agent, Multi-Agent Systems and Robotics (ISAMSR), 2016 2nd International Symposium on* (pp. 34-39). IEEE.

23. Subramainan, L., Yusoff, M. Z. M., & Mahmoud, M. A. (2015, August). A classification of emotions study in software agent and robotics applications research. In *Agents, Multi-Agent Systems and Robotics (ISAMSR), 2015 International Symposium on* (pp. 41-46). IEEE.

24. Mahmoud, M. A., & Ahmad, M. S. (2015, August). A self-adaptive customer-oriented framework for intelligent strategic marketing: A multi-agent system approach to website

development for learning institutions. In Agents, Multi-Agent Systems and Robotics (ISAMSR), 2015 International Symposium on (pp. 1-5). IEEE.

25. Jassim, O. A., Mahmoud, M. A., & Ahmad, M. S. (2015). A Multi-agent Framework for Research Supervision Management. In Distributed Computing and Artificial Intelligence, 12th International Conference (pp. 129-136). Springer International Publishing.

26. Mahmoud, M. A., & Ahmad, M. S. (2016, August). A prototype for context identification of scientific papers via agent-based text mining. In Agent, Multi-Agent Systems and Robotics (ISAMSR), 2016 2nd International Symposium on (pp. 40-44). IEEE.

27. Mahmoud, M. A., & Ahmad, M. S. (2015, August). A self-adaptive customer-oriented framework for intelligent strategic marketing: A multi-agent system approach to website development for learning institutions. In Agents, Multi-Agent Systems and Robotics (ISAMSR), 2015 International Symposium on (pp. 1-5). IEEE.

28. Moamin, M. A. H. M. O. U. D., Sharifuddin, A. M., & Zaliman, M. Y. M. (2016). Development and implementation of a technique for norms-adaptable agents in open multi-agent communities. *Journal of Systems Science and Complexity*, *29*(6), 1519-1537.

29. Mahmoud, M. A., Ahmad, M. S., & Yusoff, M. Z. M. (2016, March). A Norm Assimilation Approach for Multi-agent Systems in Heterogeneous Communities. In Asian Conference on Intelligent Information and Database Systems (pp. 354-363). Springer Berlin Heidelberg.

30. Mahmoud, M. A., Mustapha, A., Ahmad, M. S., Ahmad, A., Yusoff, M. Z. M., & Hamid, N. H. A. (2013). Potential norms detection in social agent societies. In Distributed Computing and Artificial Intelligence (pp. 419-428). Springer International Publishing.

31. Kravari, K., & Bassiliades, N. (2015). A survey of agent platforms. Journal of Artificial Societies and Social Simulation, 18(1), 11.

32. Biddle, S., & Goudas, M. (1997). Effort is virtuous: Teacher preferences of pupil effort, ability and grading in physical education. *Educational Research*, *39*(3), 350-355.

33. Abdullah, M. Y., Bakar, N. R. A., & Mahbob, M. H. (2012). Student's Participation in Classroom: What Motivates them to Speak up?. *Procedia-Social and Behavioral Sciences*, *51*, 516-522.

34. Kamarudin, N., Halim, L., Osman, K., & Meerah, T. S. M. (2009). Pengurusan penglibatan pelajar dalam amali sains. *Jurnal Pendidikan Malaysia*, *34*(1), 205-217.

35. Pace, C. R. (1990). The Undergraduates: A Report of Their Activities and Progress in College in the 1980's.

36. Stuchlíková, I., Gläser-Zikuda, M., & Janík, T. (2013). Emotional Aspects of Learning and Teaching: Reviewing the Field− Discussing the Issues. *Orbis scholae*, (2), 7-22.