Designing an Agent-based Learning Environment – a Preliminary Study on a Pre-service Teacher Course

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Background: Many of the agent-based products available to education today have been largely confined to games and instructional media that are often produced commercially by non-instructional professionals. Most of them lack customizability and are difficult to integrate into individual subject curriculum. With more agent authoring tools available and the proliferation of client-end computing, classroom teachers can now author their own agents pedagogically to produce learning environments that meet their predetermined objectives.

Aims: To experiment the use of agent technology with a class of pre-service teachers (aka trainee teachers). It hopes to achieve two objectives: (1) to understand how well the agent technology is accepted by the trainee teachers, and (2) to reveal any difficulty in designing the agent-based learning environment.

Sample: 16 pre-service teachers took part in this study. All of them were trainees from an educational technology module that had a main component in designing learning environment. They were second year students doing a Diploma-in-Education course in their own field of specialization.

Method: Pre-service teachers were to design agent-based learning environments on their own. A questionnaire was used to obtain summative assessment from the participants at the end of the course. The score from the questionnaire was used to gauge the trainee teachers' acceptance for their learning experience. Trainee teachers' weekly self-reporting Weblog was used as a formative assessment on their learning processes and difficulties.

Results: This study found that agent technology was well received by the trainee teachers albeit concerns for support by schools and the need to learn programming skills. Generally, trainee teachers were enthused by the use of scenes to support their lessons. They regarded their learning experience as positive and meaningful. They also believed that such technology would be helpful in promoting interest in their classroom teaching.

Conclusion/Recommendations: Based on the results, agent-based technology is recognized as a useful tool to support classroom learning. This study recommends two measures: (1) to build a repertoire of customizable scene templates focusing on very small and specific content areas, (2) to organize optional basic agent scripting training program prior to the commencement of the course for those who are weak at programming skills.

Keywords: Pedagogical agent, agent-based learning, learning environment.

一個爲教師培訓所設計的基於代理學習環境的初步研究

背景：通常基於代理的多數軟體都是由非教育專業人士開發出來的， 如遊戲等，它們往往很難滿足學科教師的教學需要從而被整合到實際教學過程中。隨著代理工具以及代理計算技術的不斷發展，學科教師現在也可以利用代理工具較爲容易地製作出基於代理的教學軟體來滿足自身教學需要以及輔助學生學習。

目的：探索代理技術在一門爲培訓教師所開設的課程中應用，以期達到兩個目標：1）瞭解培訓教師對於代理技術的接受情況；2）尋求代理學習環境設計的困難所在。

調查對象：16 名培訓教師。他們都是新加坡國立教育學院二年級的學員，畢業以後他們將拿到教育文憑。在本研究中，他們正參加一門教育技術課程的學習，該課程的一個主要作業就是設計一個基於教育技術的學習環境。

調查方法：這些培訓教師被要求獨立設計一個基於代理的學習環境。在課程結束前他們需填寫一份問卷調查。這份問卷調查主要是用來測量他們對代理技術的接受程度。同時，它們還被要求每週用博客來寫一份周記，記錄他們的學習過程，心得以及碰到的困難等。

調查結果：研究結果顯示，儘管培訓教師需要學習一些編程技術，但他們都能較好地接受代理技術以及情景概念，他們也都很樂意嘗試使用代理技術中的情景來支援學習環境的製作。他們認爲本課程的學習很有意義，同時他們也相信代理技術對提高學生的學習興趣將會有幫助。

總結：研究結果表明基於代理的技術對學生的學習是一個很有幫助的工具，同時建議：1）建立一個基於學科內容的情景庫，庫中的情景可以被教師適度改變以滿足不同需要；2）最好能夠對編程技術不高的學員預先進行必要的技術培訓。

關鍵字：基於教學法的代理, 基於代理的學習, 學習環境

1. Introduction

Designing learning environments involving pedagogical agents is new to the teachers in Singapore. Despite strong evidence of positive results reported by many studies conducted in the West (e.g. Baylor, 2002; Buisine, Abrilian, & Martin, 2004; Clarebout, Elen, Johnson, & Shaw, 2002; Johnson, Rickel, & Lester, 2000; White, Frederiksen, Frederiksen, Eslinger, Loper, & Collins, 2002), the adoption of agents for designing learning environment for classroom use is slow and limited. It is in this light that this study is initiated. It involved a class of pre-service teachers taking a course in Diploma in Education at the National Institute of Education. The main purpose of the study is to find out how instructional design may incorporate agent technology and how well trainee teachers perceive their learning using this new technology.

There are some initial concerns about teaching trainee teachers the use of agent technology. First, the demand on technical competency. Trainee teachers need to have two basic skills - the agent scripting skill and basic HTML coding skill in order to animate the agent. This is a challenging task for those who have little or no prior programming experience. Second, the use of scenes to contextualize the learning process. This is rather new to most of the trainee teachers and can be demanding for some. Scenes, like cases, scenarios and problems, have the potential to provide realistic settings for meaningful learning by situating learners in authentic activities (Duffy & Jonassen, 1992). Last, the task of integration, which requires the trainee teachers to put together the various components (animations, speech, dialogue and scenes) with sound pedagogy to produce a meaningful agent-based learning environment. All these requirements are fundamental to the proper integration of ICT in teaching and they are the key issues for this paper. For research purpose, these issues are condensed into two questions which will be answered in the respective sections that follow. The two questions are:

1.1 What is the acceptance level of agent-based instruction reported by the trainee teachers?

1.2 What are the difficulties in designing agent-based learning environments?

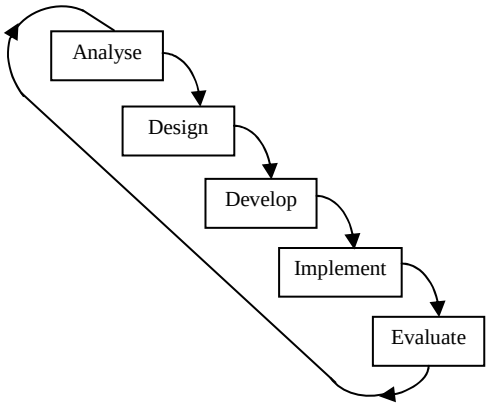
2. Designing an Agent-based Learning Environment

2.1 The Model for the Design

Traditionally, most instructional design courses use ADDIE (see Figure 2.1) as a model to introduce instructional design processes. This model was popular in the eighties because of its straightforwardness and the strong support it received from instructivistic practitioners. However, with the advent of constructivism, it now faces criticism for the lack of objectivity and the inability to produce meaningful learning process (Mendonca, 2003). ADDIE model, although appear to lose ground from the constructivist camp; is still a useful instructional model to many ‘moderate’ constructivists, especially to the designers of online courses. This being so because online learning is still very much individualistic and deals primarily with elementary content knowledge which is easier to learn in an instructivist’s

environment. This paper, thus proposes adopting the ADDIE model but with modifications to accommodate the constructivists' requirements.

Figure 2.1: ADDIE Model



Two modifications were done to the original ADDIE model. First, the components "Implement" and "Evaluate" were removed from the model because trainee teachers did not have the opportunity to implement their designs in a real school setting. Second, an additional element called "EPTT" (see Table 2.1) was added to complement the component "Analyse". "Analyse" refers to analysing the learners' attitude, skills and knowledge prior to taking the course and are collectively called the "ASK" of learners. It was felt that the requirement to know the learners' pre-learning conditions was insufficient because it disregards the designer's epistemological belief which has a strong bearing on the designer's expectations and hence his/her approaches. Designers who understand their epistemological stance tend to be more aware of the limits of their pedagogy and are more likely to produce meaningful and logical instructional products. With the introduction of EPTT, a more balanced design process between learners' characteristics and the designer's expectations may be possible. Hence, this paper suggests that "Analyse" should involve the analysis of both learners and designer.

Table 2.1: The EPTT

Domain to consider	What to apply?
Epistemological Perspective	Constructivism, Activity Theory, Experiential Learning etc.
↓ ↓	
Pedagogical Paradigm	Case-based, Problem-based, Exploratory, Research-based etc.
↓ ↓	
Theoretical Basis	Multimedia Learning Theory, Information Processing Theory etc.
↓ ↓	
Tools	1. Scene for contextualization 2. Microsoft Agents for scaffolding

EPTT in Table 2.1 stands for "Epistemological Perspective", "Pedagogical Paradigm", "Theoretical Basis" and "Tools". EPTT requires the designer to first examine his/her own belief of learning (Epistemological

Perspective) before the design. The designer then looks for proper pedagogical approaches to support his/her epistemology. For example, a constructivist designer would probably choose cases or problems for his/her instructions. (Jonassen, 2000; Jonassen, Howland, Moore, & Marra, 2003; Smith & Ragan, 1999). Next, the designer will have to identify a relevant theory to guide the design. Finally, the designer needs to select instructional tools to facilitate the learning process. A point to note is that because agents and scenes are part of the intervention in this empirical study, all trainee teachers are supposed to include them as facilitating tools in their designs. Facilitation is an essential process for effective learning (Davis, & Davis, 1998; Schunk, 2000). Agents and scenes will be discussed in detail in the following sections.

2.2 Pedagogical Agents and Microsoft Agents

Since the existence of agent in education, the term "agent" has received a number of different semantics depending on the role it plays. Some called it instructional agent (Clarebout et al., 2002); others called it pedagogical agent (Baylor, 2002; Clarebout et al., 2002; Craig, Gholson, & Driscoll, 2002; Johnson et al., 2000; Kristen, Person, Adcock, van Eck, Jackson, & Marineau, 2002; Smith, Afflect, Lees, & Branki, 1999) or intelligent agent (Goecks & Shavlik, 2000). Shaw, Johnson, & Ganeshan (1999, p. 1) defined pedagogical agents as "animated characters designed to operate in an educational setting to support or facilitate learning". This matches the scaffolding role the agent needs to play in this study. Thus, pedagogical agent will be used in the subsequent discussions in this paper.

The effect of pedagogical agents on learning has been equivocal because of the complex nature of involvement it offers in the learning process. Some used agents as mediating tools while others use them to increase productivity. But among all, one strong attribute stood out against the rest is its ability to influence positively a learner's perception of learning. Many believe that agents are useful not because of their ability to animate but their capacity for speech and the ability to mimic lifelike behaviours - a characteristic described as *persona*. A persona is a personified agent that co-exists with the user in a learning environment (Mulken et at., 1998). By personifying the agent, a user tends to believe that the agent is "real" and helpful, and as a result, enjoys a more positive learning experience (e.g. Baylor & Ebbers, 2003; Lester, Converse, Kahlet, Barlow, Stone, & Bhogal, 1997; Mulken, Andre, & Muller, 1998). Supporting findings for persona effect includes Johnson's et al. (2000) study on agent-based interactive learning environment. They found that agents with humanlike behaviour such as gaze and deictic gesture were more effective in motivating learning. A plausible explanation to this is that behaviour aims at fulfilling certain instructional purposes tends to lighten the cognitive load of the learners. The effect is equivalent to having a tutor or facilitator in a learning environment. Learners with low cognitive load normally suffer less fear for failure and are therefore keener to learn – a situation described by an OECD (2002) report as "high challenge" with "low threat", an environment regarded as ideal for learning.

In another study, Lester, Stone, & Stelling (1999) investigated problem-based learning facilitated by lifelike pedagogical agents. They found that learners learn better in solving complex problems when the learning path was assisted by the agent's interactive feedback and timely advice accompanied by well-tuned human behaviour. They cautioned that an agent's behaviour must be linked to its role in facilitation within

the context, in particular, to engage learners in a variety of explanatory, advisory and believability-enhancing behaviours. In other words, the finding pointed out the importance of context and the need to have well thought-out instructional strategies.

In all, the above findings demonstrate common ideas of what constitutes to a conducive agent-based learning environment, these are: right choice of context, proper coordination of agent's speech, movements and gestures, and appropriate pedagogical approaches.

There is a need to include one more consideration for this study, that is, the choice of agent. Because the bulk of the trainee teachers are new to agent programming, the agents must be simple and easy to animate. There is hardly any such agent until 1992 when Microsoft Corporation officially released its proprietary agent technology to the public (Wissick, 2002). Since then, Microsoft agents have been widely incorporated in business such as web portals and presentations. But its use in education is still limited. There are altogether four agents available for public use; they are Peedy, Merlin, Genie and Robby (see Figure 2.2).

Figure 2.2: Microsoft Agents (from left: Peedy, Merlin, Genie and Robby)

Microsoft agents contain features that are very suitable for producing agent-supported learning environment at classroom level. There are several reasons. First, these agents are customizable and re-creatable. Anyone who wants to create a new agent character (other than the given four) can use the development kit downloadable from Microsoft Corporation. Second, the agent is fully 3-D animated and has preprogrammed lifelike behaviour. Lifelike behaviour is important to induce "persona" effect. Also, the animation is quite straightforward, using a near English-like scripting language. Third, the agent is able to deliver synthesized speech and respond to spoken commands, a very friendly tool for those who need special attention. Fourth, it can be programmed to interact with the environment to enhance human-computer interface through the use of specialized software. Last, which is also the most important one; it is license-free and can be installed in any window-based computers. This allows the trainee teachers to practise the agent programming skill at their own time at their home. This is considered crucial for new learners. Since Microsoft agents possess many of the important ingredients that match the requirements for designing an agent-based learning environment, they are adopted and used in this study.

2.3 Use of Scenes

Scenes are commonly used in plays, dramas and movies. Besley, Bhangal, & Farr (2002) called a scene an independent piece of a whole movie that helped to advance the storyline. When a movie gets too complex or lengthy,

scenes play the role of segmenting the storyline into more manageable components and yet maintaining the flow and continuity (Gooch, 1988). In the like manner, when scenes are used in instructions, they can help focus the essentials, provide in-depth study on the parts rather than the whole for complicated issues.

To produce scenes, the following elements suggested by Selvester's (2004) are required:

1. Dialogue
2. Actions and gestures
3. Characters' thoughts
4. Expositions
5. Description of setting
6. Comments or observations by the author or narrator
7. Transitions from the previous scene into the next scene
8. Contribution to the plot
9. Successful or failed outcomes

Many of the above elements can be fulfilled by using Microsoft agents. For example, an agent can play a character in a scene, converse with another agent with gestures and movements to induce a conflict or lay the background of an issue which can then form the context for learning. Scene-based learning is analogous to constructivist learning. Scene-based learning uses scenes as a catalyst to scaffold whereas constructivist learning uses tools such as case study and problems to support learning (Davis, & Davis, 1998; Jonassen, 1998; Jonassen, 2000; Pieters, 1995; Schunk, 2000). Both scenes and constructivist environments emphasize authenticity but scenes are able to provide a more realistic situation by its characters' interplay and dialoging. More importantly, scenes can be fabricated to achieve a certain goal without compromising authenticity.

2.4 Producing the Learning Environment

Previous discussions outlined the tools and components necessary for designing and constructing the agent-based learning environment. In consolidation, what the trainee teachers need to do in the course is to first understand the design model given in Figure 2.1 and Table 2.1. They then use the model to identify a very specific idea in the content area which they find it difficult to teach, e.g. human adaptation to environmental changes, measures to curb dolphin's extinction etc. Two things they have to take into consideration when making their choices: (1) choose only ideas that can be acted out through the use of scenes and (2) choose ideas that can be learnt through a problem or an issue. Once the idea to learn is identified, the trainee teachers will need to work out a situation containing the problem or issue. The problem or issue will be segmented into smaller and manageable episodes called scenes. The scenes are then introduced to the learners with the help of agents. Agents will be programmed to play the role of a facilitator in the scenes, highlighting the crux of the problems through their voices and animations. The learning process will culminate in activities such as group discussion or presentation.

3. Methodology

3.1 The Participants

A group of 16 pre-service teachers took part in this study. The pre-service teachers were trainees from an educational technology module that had a main component in designing learning environment using agent technology. All trainees were second year students doing a Diploma-In-Education course in their own field of specializations. The breakdown of the trainees' background in terms of Content Specialization (abbreviated as CS) and gender is given in Table 3.1.

Table 3.1: Breakdown of Trainees' background

Content Specialization	No. of Male Participants	No. of Female Participants	Sub-total
General	2	6	8
Art	2	0	2
Home Economics	0	1	1
Chinese	0	2	2
Malay	0	3	3
Sub-total	4	12	**Total = 16**

3.2 Implementing the Course

The course consisted of ten in-class and two off-class sessions. Eight out of the ten in-class sessions were devoted to designing agent-based learning environment. The rest (including off-class sessions) were lessons focusing on giving general concepts on instructional strategies, agent's roles and supports in learning environments. Trainee teachers spent all the eight sessions face-to-face including learning a new tool called MASH (a specialized tool used for scripting Microsoft agents), understanding the concept of scene, practising the scripting skills and assembling the parts into deliverables.

To obtain regular feedback from the trainee teachers on their learning experience, the course required the trainee teachers to write weekly reflection in the form of Weblog (aka Blog) on what they had learnt, what learning difficulties they had encountered and what their suggestions were for improvement. Reflections were uploaded to Blogspot, a public domain web-based platform for hosting self-reported journals. Trainee teachers were told that blogging was graded and formed part of the total assessment for the course.

At the end of the course, trainee teachers were to produce a web-based integrated agent-based project in a subject discipline of their choice. The project carried 50% of the final grade.

3.3 The Research Design

This study adopted an evaluative design to elicit information pertaining to the trainees' reported learning experience. A questionnaire was used as an instrument to obtain summative assessment from the participants at the end of the course (Bell & Opie, 2002). This provides a means to answer research question 1. Trainee teacher's weekly self-reporting Weblog was used as a formative assessment to obtain trainee teachers' learning experiences and their general comments on learning. This serves to answer research question 2. Finally, the overall score from the questionnaire was used to measure the trainee teachers' self-reported learning profile (aka perceived learning profile). The profile is used as a means to gauge the trainee teachers' acceptance for their learning experience.

3.4 The Questionnaire

A questionnaire consisting of 36 self-constructed items was used. It has four subscales: (1) usefulness of MASH, (2) proficiency in scripting the agents, (3) perception of the scene concept and (4) perception of scene-based activities. All subscales contained 5-point Likert-type items and one open-ended question. Each item consists of five options: Strongly Agree, Agree, Not Sure, Disagree and Strongly Disagree. Table 3.2 gives the breakdown of the questionnaire structure. The open-ended question allowed feedback on areas that were not covered

by the Likert-type items. The questionnaire was administered during the last session of the course. There was no time limit for taking the questionnaire.

Table 3.2: Breakdown of Questionnaire Structure

	Subscale			
	Usefulness of MASH (UM)	Proficiency in scripting the agents (PSA)	Perception of the scene concept (PSC)	Perception of scene-based activities (PSBA)
No. of Likert-type item	7	10	6	9
No. of Open-ended question	1	1	1	1
Sub-total	8	11	7	10

3.5 Trainee Teachers' Perceived Learning Profile (LP)

Positive perception has long been known to be related to meaningful learning (Eggen & Kauchak, 1999) and meaningful learning is likely to produce desirable educational outcome. It is therefore important to know how trainee teachers perceive their learning experience. The total score from the questionnaire is used as a surrogate measure for the trainees' self-reported learning experience. Understandably, the score reflects the trainees' own belief of learning which can be a result of subjectivity. The score from the questionnaire was called perceived learning profile, abbreviated as "LP".

4. Data Analysis and Discussions

4.1 The Questionnaire

The questionnaire is an important instrument in this study. It must meet acceptable criteria if the information it collects is to be useful. Below are its reliability and validity.

4.1.1 Reliability

Six items were removed from the original questionnaire either because of non-contribution to variance or low item-total correlation ($r<.3$) (Nunnally & Bernstein, 1994). The reminding 30 Likert-type items and four open-ended questions then formed the revised questionnaire to be used in the study (see Appendix A). The revised questionnaire had a Cronbach's Alpha of .891 which fell well within the acceptable range of .6 to .9 (Aron & Aron, 2003).

4.1.2 Validity

The divergent validity of the questionnaire was verified by examining the inter-correlations between the subscales (Nunnally & Berstein, 1994). The result is tabulated in Table 4.1. It can be seen that all subscales correlated significantly with LP implying that all subscales were able to account significantly the variance of the perceived learning. All subscales also had insignificant correlations with one another except for the pairs PSC-UM ($r = .631$) and PSC-PSA ($r = .629$). This could be due to the fact that scenes are perceived to be closely tied to its application which is also strongly linked to the tools and skills that mediate the application.

Table 4.1: Inter-correlations of Subscales

	UM	PSA	PSC	PSBA	LP
UM	1	.378	**.631**(**)	.159	**.726**(**)
PSA	.378	1	**.629**(**)	.329	**.751**(**)
PSC	**.631**(**)	**.629**(**)	1	.476	**.900**(**)
PSBA	.159	.329	.476	1	**.657**(**)
LP	**.726**(**)	**.751**(**)	**.900**(**)	**.657**(**)	1

**Correlation is significant at the .01 level (2-tailed).

4.2 Acceptance Level of Agent-based Instruction Reported by the Trainee Teachers

Acceptance level was measured by the means of the subscales and the total scores of the questionnaire. Table 4.2 contains the means and relevant statistics for the overall scale and subscales.

Table 4.2: Descriptive Statistics for Overall Scale and Subscales

	Minimum score	Maximum score	Mean score	Percent Mean	Std. Deviation
UM	12	28	25.38	72.5	3.76
PSA	18	29	22.69	75.6	2.96
PSC	17	30	24.75	82.5	3.42
PSBA	22	35	28.50	81.4	3.48
LP	76	122	101.31	72.4	9.74

Trainee teachers seemed to accept the use of scene concept (PSC) in agent-based environments more than the others (see Percent Mean). This is followed by the use of scene-based activities (PSBA) and the proficiency in scripting the agents (PSA). The high PSC score (82.5%) which measures the understanding of scene usage and scene effectiveness, is a strong indication that the scene concept is well explained to and well accepted by the trainee teachers. This tends to imply that the revised ADDIE model is useful and effective in conveying the needs to analyse both the learners and designer. The introduction of EPTT could have helped in this regard by lightening the cognitive load of trainee teachers. By following an organized structure of thought which the EPTT aims to provide, trainee teachers are more aware of the nature of the process and are more confident in their doing. This phenomenon is consistent with the ideal learning condition characterized by a "high challenging but low threatening" environment described by the OEDC (2002) report. Of course, the result could be better verified by comparing the trainee teachers' perceived learning with their actual performance but this would face one major constraint, that is, the performance would not be linked to applicability of product because the deliverables cannot be tested in a real classroom situation. As in all research studies, design effectiveness needs to be tested for practicality or the value of assessment would not hold water if performance is to be measured solely by a set of classroom rubrics. With this constraint, this study limits the measurement to only perceived learning.

The high range of subscale scores also help to allay the initial concerns highlighted in the Introduction part (section 1) of this paper. The statistics did not reveal any adverse tendency to learning new concepts and technical skills. Indeed, it is quite surprising to learn that technical ability and the usefulness of the scripting tool were rated unexpectedly high in a course like this which had so many novelties to learn. It is also very encouraging to see that the reported perceived learning (LP) stood at a 72.4%.

To a certain extent, the result could be taken as a form of acknowledgement to a satisfactory introduction of agent-based technology in instructional design.

4.3 Difficulties in Designing Agent-based Learning Environments

Analysis of the trainee teachers' weekly reflections and the open-ended questions from the questionnaire provided the source to know their learning problems. The main concerns raised by the trainee teachers were tabulated in Table 4.3.

Table 4.3: Main Concerns Regarding the Agent-based Learning

Trainee Teachers' Concerns Pertaining to Learning the Course
Concerns related to UM
1. Access to the MASH software is only confined to NIE's laboratories. Using the trial version software allows only a month of usage. 2. MASH does not support speech in Chinese. It does not favour trainee teachers specializing in Chinese teaching.
Concerns related to PSA
1. It takes great effort to script the agents as the program does not tolerate any slightest mistake. This makes the scripting very time-consuming. 2. I am weak in programming so I wish to have longer hands-on practice time in class. 3. Hope to have readily made agent templates that can be adopted and adapted for a rapid prototype lesson.
Concerns related to PSC
1. Scene is good in attracting students' interest but to have good scenarios or events to move the scenes needs good content knowledge and some creativity. 2. Need a good deal of guidance and consultation from the tutor. Not all topics are suitable for use in scene-based environment.
Concerns related to PSBA
1. Not enough time to complete the project and design the activities. Especially trainees with Chinese specialization need extra effort to translated the scene events. 2. Creating agent-based learning environment requires manpower and time. May need a team rather than an individual to do it.
General Concerns
1. Not sure whether the delivery of the agent-based instructions would work in a school setting given the number of engine software (agent and speech) to install and the technical support available. 2. Prefer more intelligent agents like Peedy (one that has the most animations in MS agents) and more agent type to choose from.

The feedback pointed out two key areas of concern, the practicability and availability. A few asked whether such a learning environment is practical in school settings given the time and support needed. This worry is not without grounds. Normally, any new implementation in schools would not involve only the adaptation for the change but also a change in the mindset of the affected bodies. How well a change is perceived as acceptable will always depend upon the extent of need to make the change. Agent-based instruction is entirely new to the school and is expected to receive mixed reactions. Other trainee teachers queried about the extent of provision in terms of software and guidance. Software issue is an institutional issue and is not easy to tackle. Having more technical guidance is probable once agent-based instruction becomes integrated in core technology modules. In addition, a pre-course tutoring system can be implemented to support those with weak programming background. Despite these issues, the questionnaire indeed received a good number of positive feedback such as scenes help to engage metacognition, agents are able to entice students' interest and that the revised ADDIE model helped greatly in shaping their ideas of instructional design. The favourable comments also appear to agree with the high mean scores found in the subscales of the questionnaire.

5. Conclusion and Recommendations

This study attempts to address two research questions pertaining to pre-service teachers' acceptance of agent-based instruction, i.e. how well the trainee teachers perceive their learning and what their related learning difficulties are. Questionnaire and weekly reflections were the main mechanism used to collect data. Following are the findings obtained:

Generally, the new approach of instruction using the agent technology and scene concept was well received by the trainee teachers. No major issues were reported except for two: (1) the practicability and availability, and (2) the technical skills. Trainee teachers were eager to use the new technology but were skeptical of the support and time available to them. From a pedagogical point of view, the concern may be addressed by building a repertoire of customizable scene templates focusing on very small and specific content areas. This helps to ease the need to construct the instruction from scratch. Over time, hopefully the templates can grow into a resource repository and attract a community of users.

A few trainee teachers felt that the scripting and programming skills were too demanding. Since the course admission policy does not allow screening the trainees for technical skills, this study recommends organizing optional basic scripting training program prior to the course for those who are technically less inclined.

The introduction of EPTT to the original ADDIE model seems to help trainee teachers understand the design process and scene concept well. Having the designer to consider his/her epistemological perspective of learning alongside with the design process appears to make the learning task easier. This is so because designing an instructional process using a very new technology entails a lot of guts and initiatives. The EPTT in a way provides a structure for a beginner to start with. This enhances their self-confidence which may translate into higher acceptance of their learning experience.

Overall, the positive perception of learning involving agent-based instructions is a good indication to run similar courses in the future. However, care must be taken to emphasize the pedagogical purpose and instructional value of the design and possibly, to provide scripting and technical skill training prior to the course proper for those technically less inclined trainees.

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Appendix A

Results of Item Analysis for Internal Consistency

Note:
1. Q8, 19, 26 and 36 are open-ended questions. They are not included in Table 1 to 4.
2. Q16 did not produce any variance and is excluded from Table 2.
3. Items in bold print are to be discarded.

Table 1: Item-Total Statistics for Subscale UM

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Q1	21.50	12.400	.665	.575	.860
Q2	21.44	8.929	.874	.837	.810
Q3	21.81	11.096	.626	.631	.850
Q4	21.56	12.263	.409	.314	.873
Q5	22.94	11.396	.375	.500	.887
Q6	21.50	9.067	.801	.844	.823
Q7	21.50	9.067	.906	.838	.805

Table 2: Item-Total Statistics for Subscale PSA

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Q9	30.31	7.696	.519	.423	.670
Q10	30.44	6.796	.582	.504	.652
Q11	31.44	5.863	.674	.592	.625
Q12	30.44	10.129	**-.047**	.111	.738
Q13	30.44	9.463	**.168**	.655	.726
Q14	30.75	7.133	.465	.602	.684
Q15	30.31	9.163	.589	.801	.695
Q17	30.31	8.763	.442	.664	.692
Q18	30.56	9.463	**.198**	.425	.722

Table 3: Item-Total Statistics for Subscale PSC

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Q20	20.63	10.383	.321	.800	.898
Q21	20.56	9.996	.592	.840	.873
Q22	20.56	7.196	.844	.782	.819
Q23	20.75	6.600	.833	.855	.825
Q24	20.75	7.267	.848	.887	.819
Q25	20.50	8.400	.707	.798	.847

Table 4: Item-Total Statistics for Subscale PSBA

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Q27	33.25	11.400	.703	.832	.650
Q28	33.13	11.717	.658	.751	.660
Q29	33.19	9.763	.504	.970	.652
Q30	33.19	10.562	.356	.980	.689
Q31	33.25	10.200	.444	.906	.667
Q32	32.81	12.696	**.133**	.917	.719
Q33	33.13	11.983	.376	.924	.683
Q34	33.00	13.200	**-.023**	.861	.755
Q35	33.56	9.463	.664	.939	.614

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(Received: 28.6.05, accepted: 20.7.05, revised: 28.7.05)