ET60012 FOUNDATIONS OF EDUCATIONAL TECHNOLOGY

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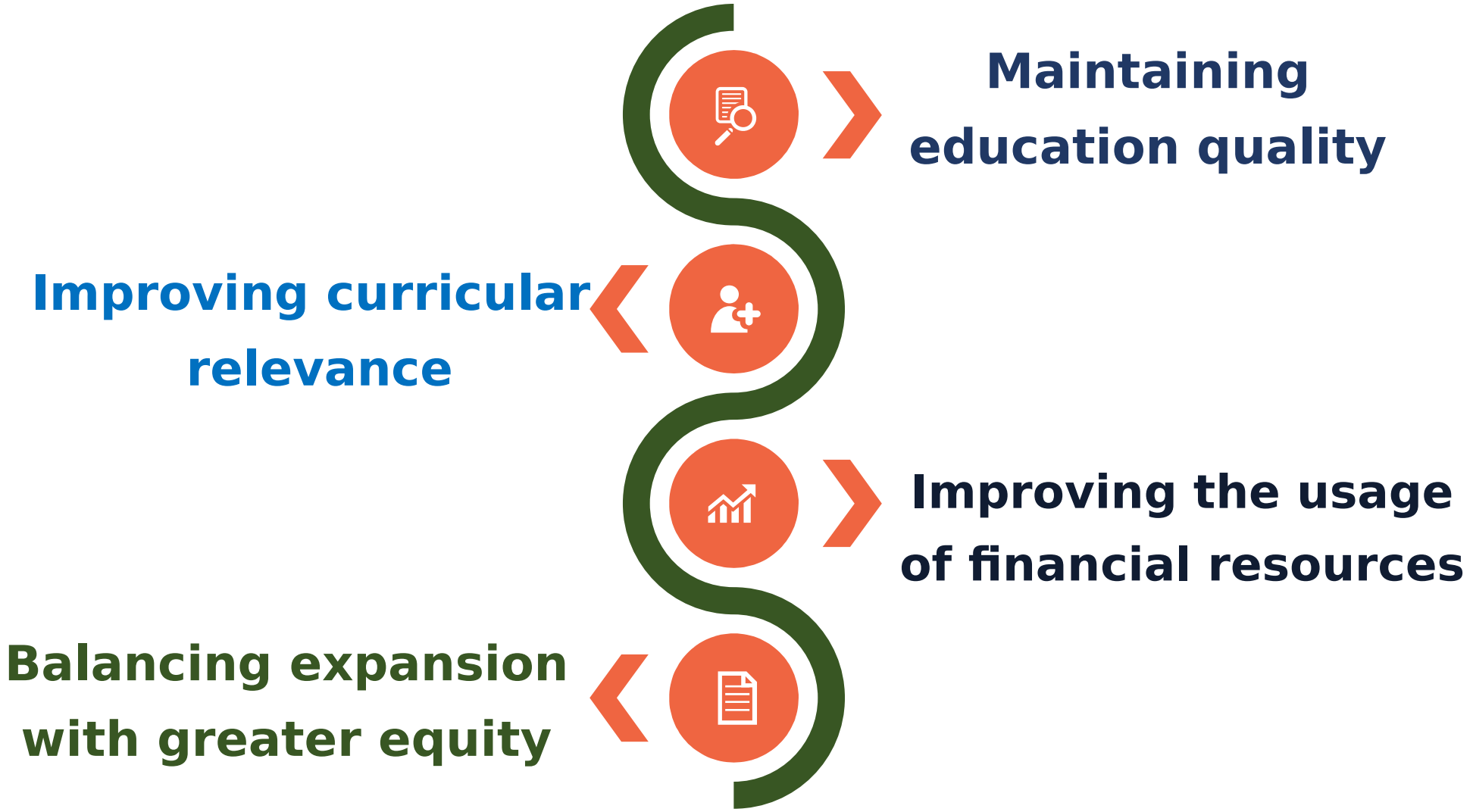
Current status, challenges and opportunities of Intelligent Tutoring System (ITS) in Developing Countries in Asia

Education in Asia

According to Asian Development Bank report (2011):

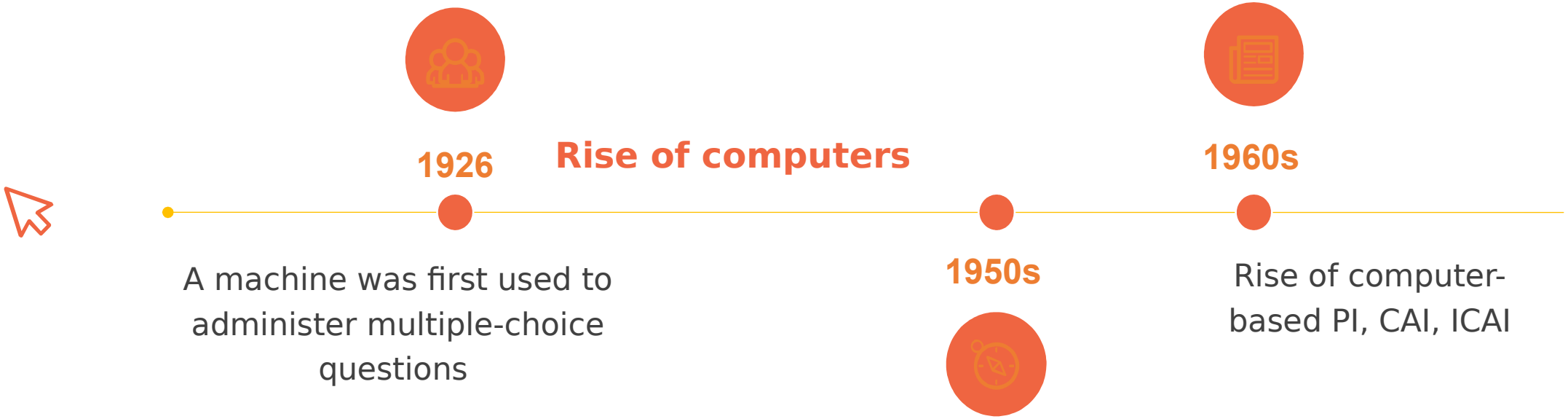
- Education sector in Asia region is growing
- More people have access to formal and informal learning

Challenges


Maintaining education quality
Improving curricular relevance
Improving the usage of financial resources
Balancing expansion with greater equity

Brief History

- 1926 : A machine was first used to administer multiple-choice questions (Shute & Psotka,1994)
- Mid-1950s: Rise of computers
- 1960s: Rise of computer-based programmed instruction (PI), CAI (Computer-assisted instruction), Intelligent CAI (ICAI)
- Collaboration between education and Artificial Intelligence(AI)
- These investigations gave rise to ITSs



Definition

An ITS is a computer-based learning environment that makes use of artificial intelligence to create educational environments that respond to both the learner's state and the instructional agenda (Graesser, Conley, & Olney, 2012).

Functions of ITS

Personalized hints

Guidance

Remediation

Emotional support

Issues addressed by this research

- Map the Asian developing countries engaged in ITS research
- Describe their research foci
- Estimate the effectiveness of ITSs developed or deployed in these countries
- Identify the limitations of current ITS research and opportunities for further study.

Four major components of ITS

01
A domain or expert model

02
A learner or student model

03
A tutor or pedagogical model

04
A user interface

A domain or expert model

It contains the following content which student is supposed to learn (Sottilare, Graesser, Hu, & Holden, 2013).

- Skills
- Knowledge
- Procedures
- Common errors
- Misconceptions

A learner or student model

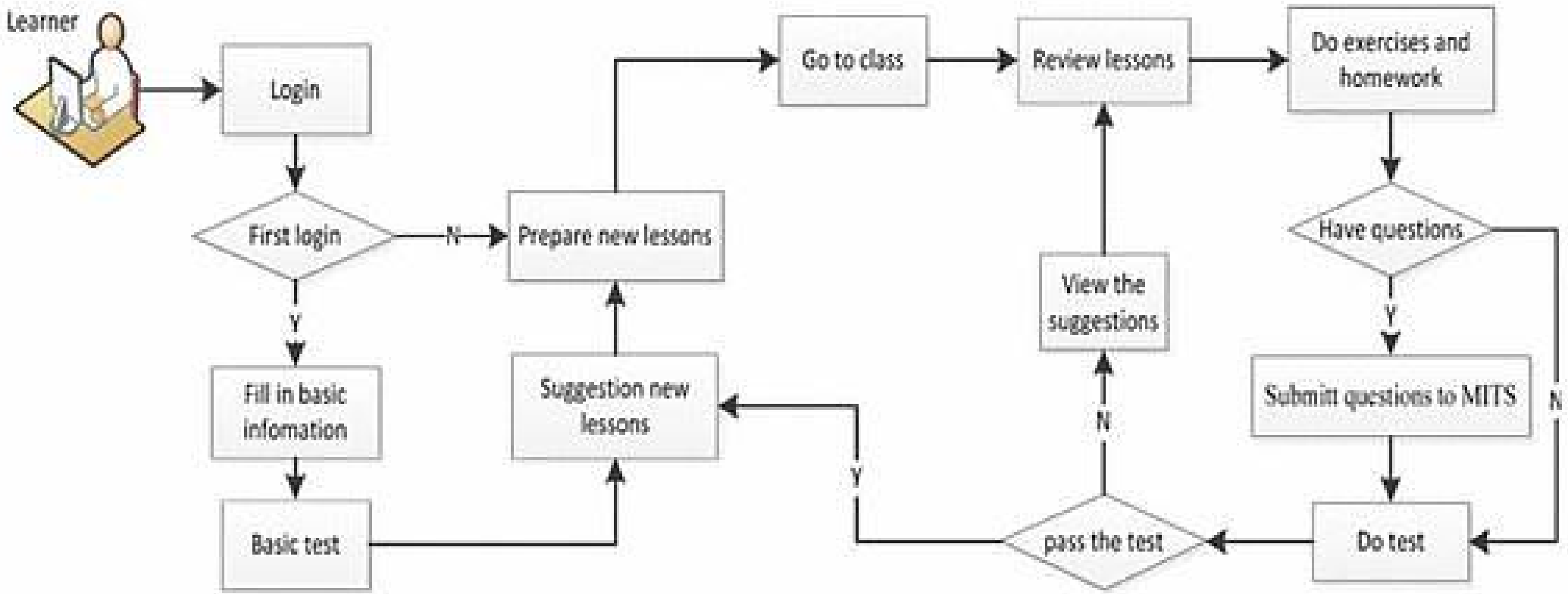
It contains the psychological states of leaners

(Sottilare, Graesser, Hu, & Holden, 2013).

- Student emotion
- Motivation

A Tutor or pedagogical model

- Regulates the interaction between the student and the system.
- Informed by both the domain model and the learner model, the tutor model selects the best teaching strategies.
- Example : Cheng et al.’s (2014) Personalized Mathematics ITS



The flowchart of Cheng et al.'s (2014) Personalized Mathematics ITS

A user interface

- Takes input from the learner and sends it to different models.
- Receives output from the tutor model and displays it to the learner.
- Example: Rodrigo et al.’s (2012) Scooter the Tutor.

Scooter the Tutor

Fig. 5. Happy expressions of Scooter

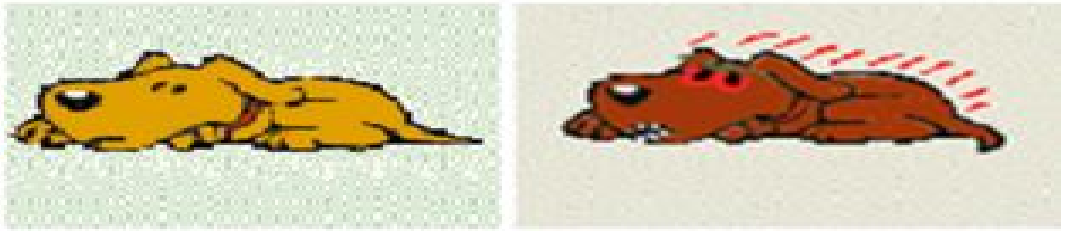


Fig. 6. Sad (left) and Angry (right) expressions of Scooter

Data collection

Keywords used

- intelligent tutoring system
- achievement
- effectiveness
- learning outcome etc.

Data base used

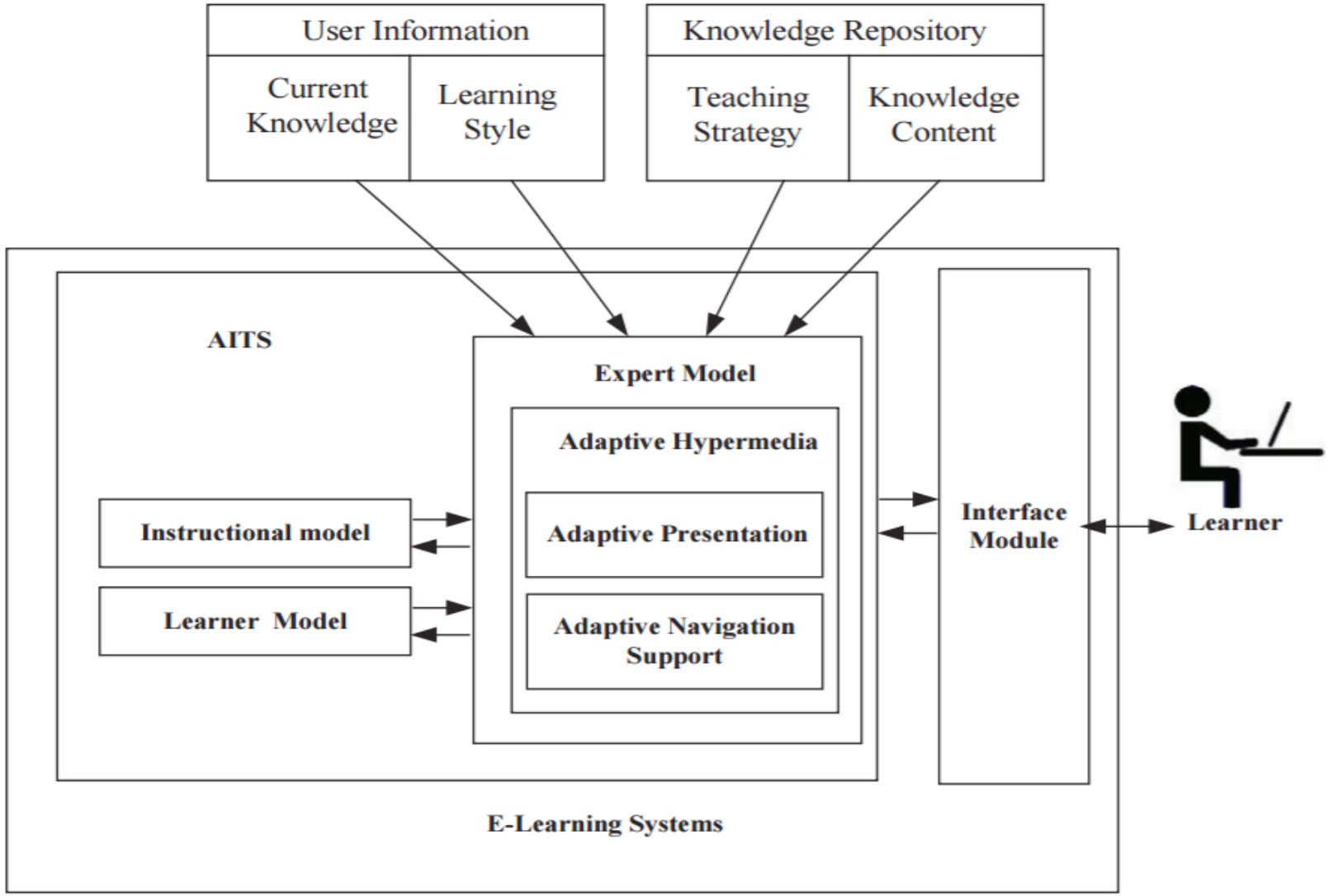
- Scopus, Web of Science, ERIC, Google Scholar and PsycINFO

Geography and foci of ITS Research in Asia

Authors	Country	Subject area	Research foci
Cheng, et al., 2014	China	Math	Development
Chung, et al, 2013	Philippines	Japanese	Development
Hwang, Tseng, and Hwang, 2008	Taiwan	Math	Development
Kazi, et al,, 2010	Thailand and Pakistan	Medicine	Development
Li, Ma, et al., 2010	China	Science	Development
Phobun & Vicheanpanya, 2010	Thailand	Not applicable	Theory-oriented
Regalado et al., 2015	Philippines	Filipino	Development
Rodrigo, et al., 2012	Philippines with US collaborator	Math	Theory-oriented
San Pedro, et al, 2014	Philippines and USA	Math	Theory-oriented
Sun, et al., 2013	China	Not applicable	Theory-oriented

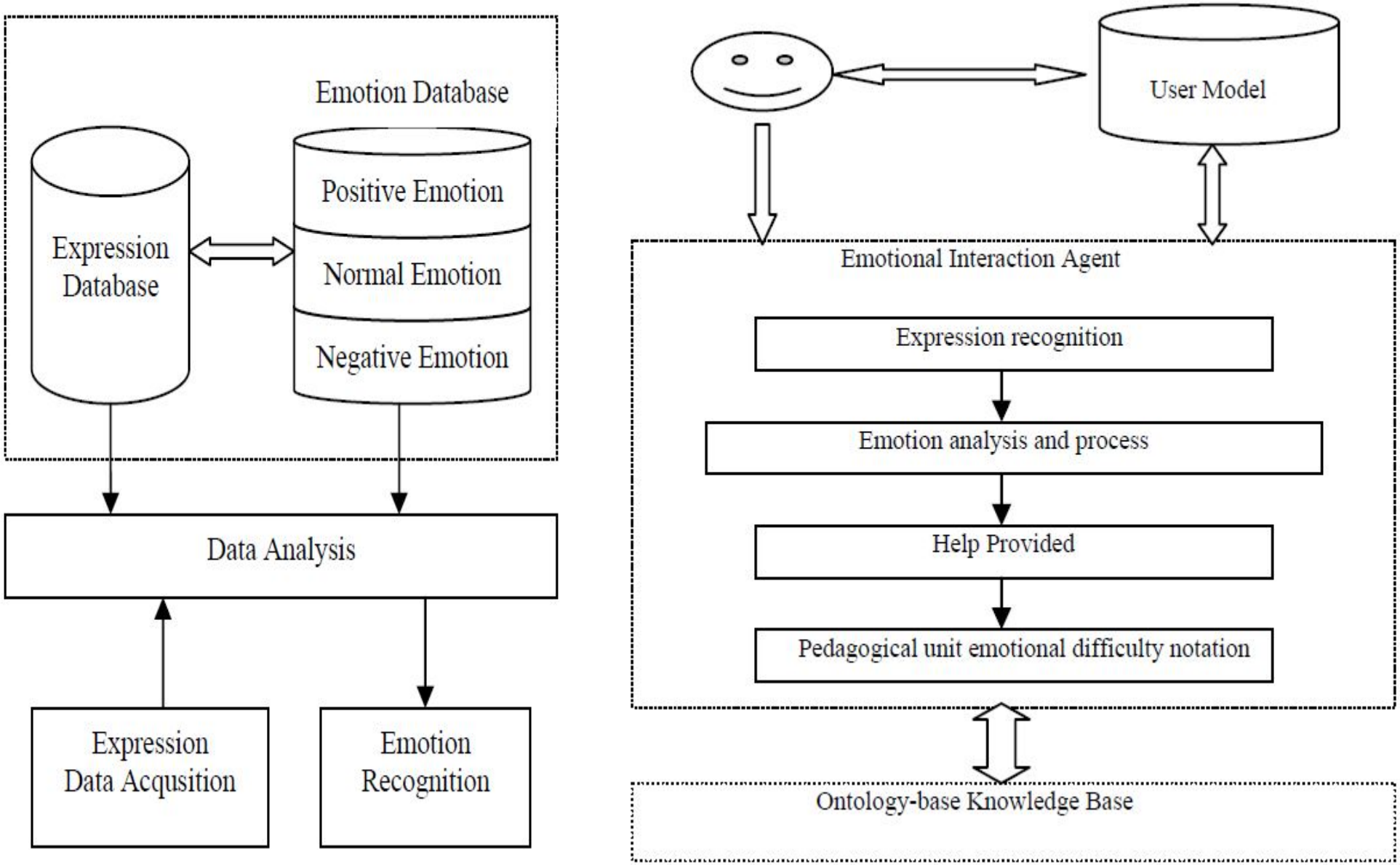
Theory-oriented ITS studies

- Explain ITS architecture or augmentations or improvements to it, minus actual implementation.
- Phobun and Vicheanpanya (2010), for example, describe the architecture and flow of an adaptive intelligent tutoring system (AITS).
- AITS combines the features of an ITS with those of adaptive hypermedia.



Phobun and Vicheanpanya (2010)'s AITS

- Some theoretical papers to expand existing ITS by including new capabilities and features.
- Sun et al. (2013), attempts to address ITSs' lack of emotion, and how this shortcoming may undermine learners' motivation and learning.
- Describe how emotion recognition can be built into these systems.

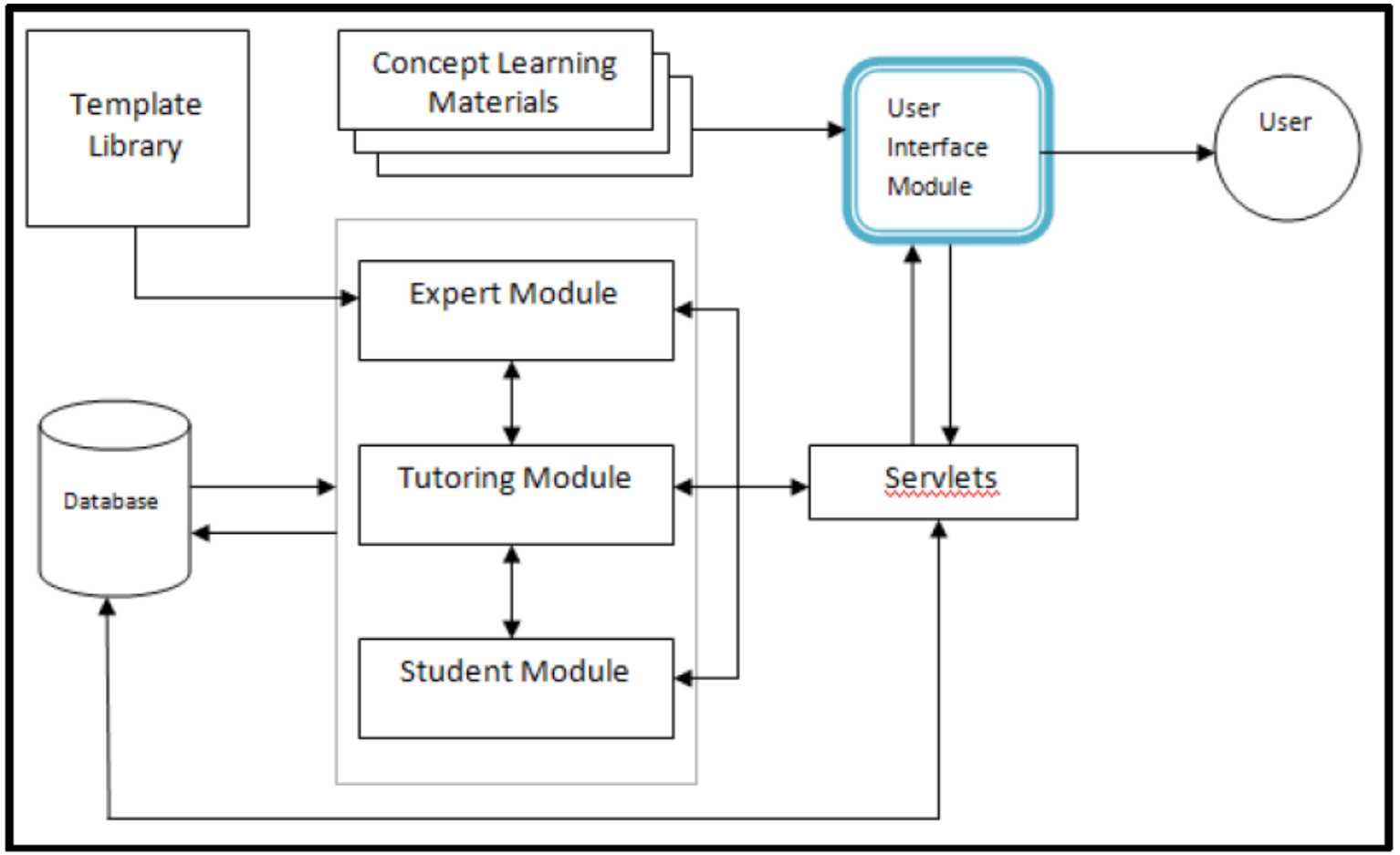


Sun et al.(2013) model

ITS development

Salinlahi (Regalado, et al., 2015)

- ITS that teaches two type of exercises: translation and creation.
- User interface: Responsible for interactions between the student and the system
- Expert model: Two analyzers for each type of exercise
- Student model: Represents what the student has and has not learnt
- Tutor model: Tracks student attempts



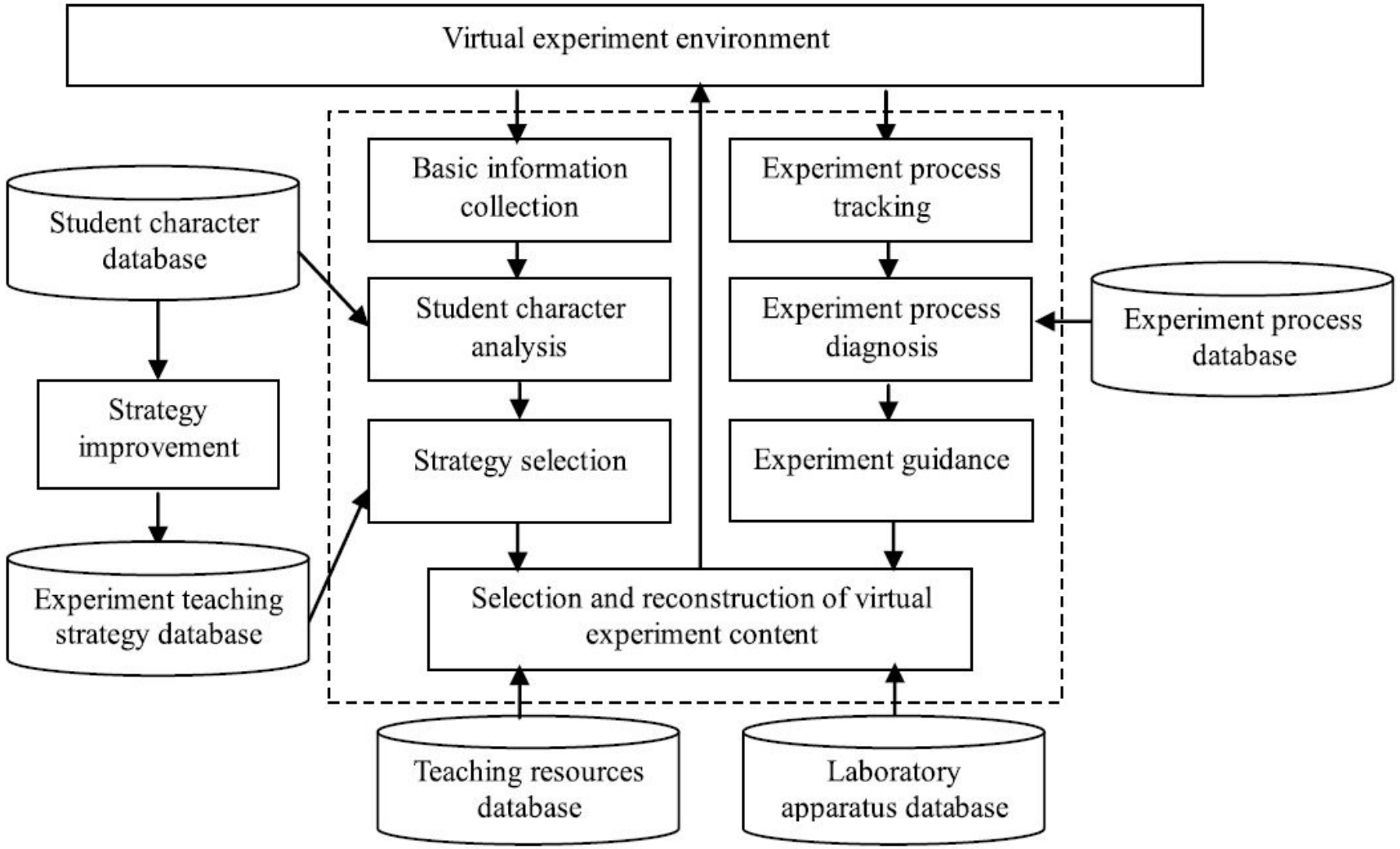
Regalado, et al., (2015)'s Salinlahi

Principles

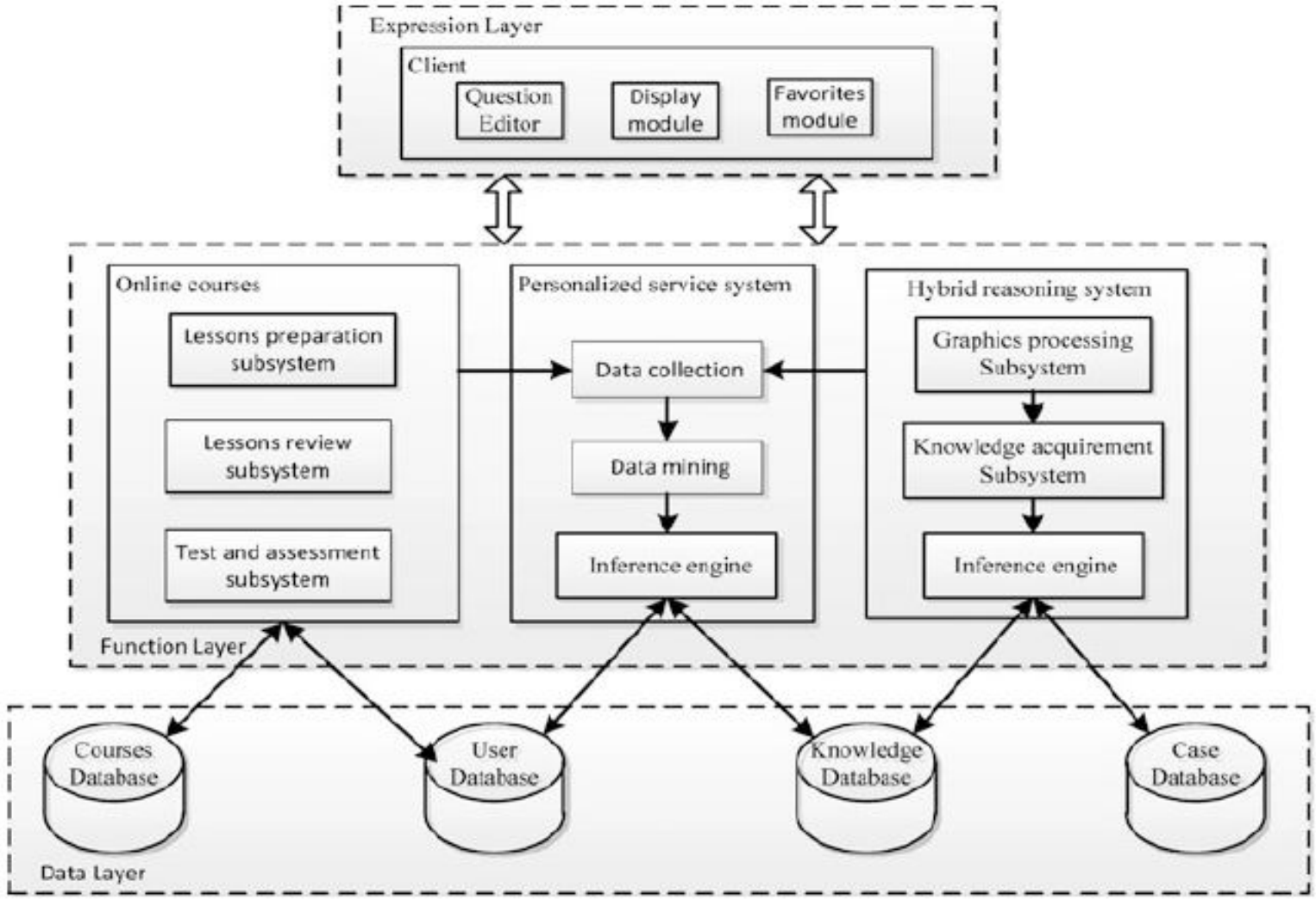
Li, et al.’s (2010) ITS based on Multi-agent

To collect the basic information of students and analyze the characters of students according to the information.

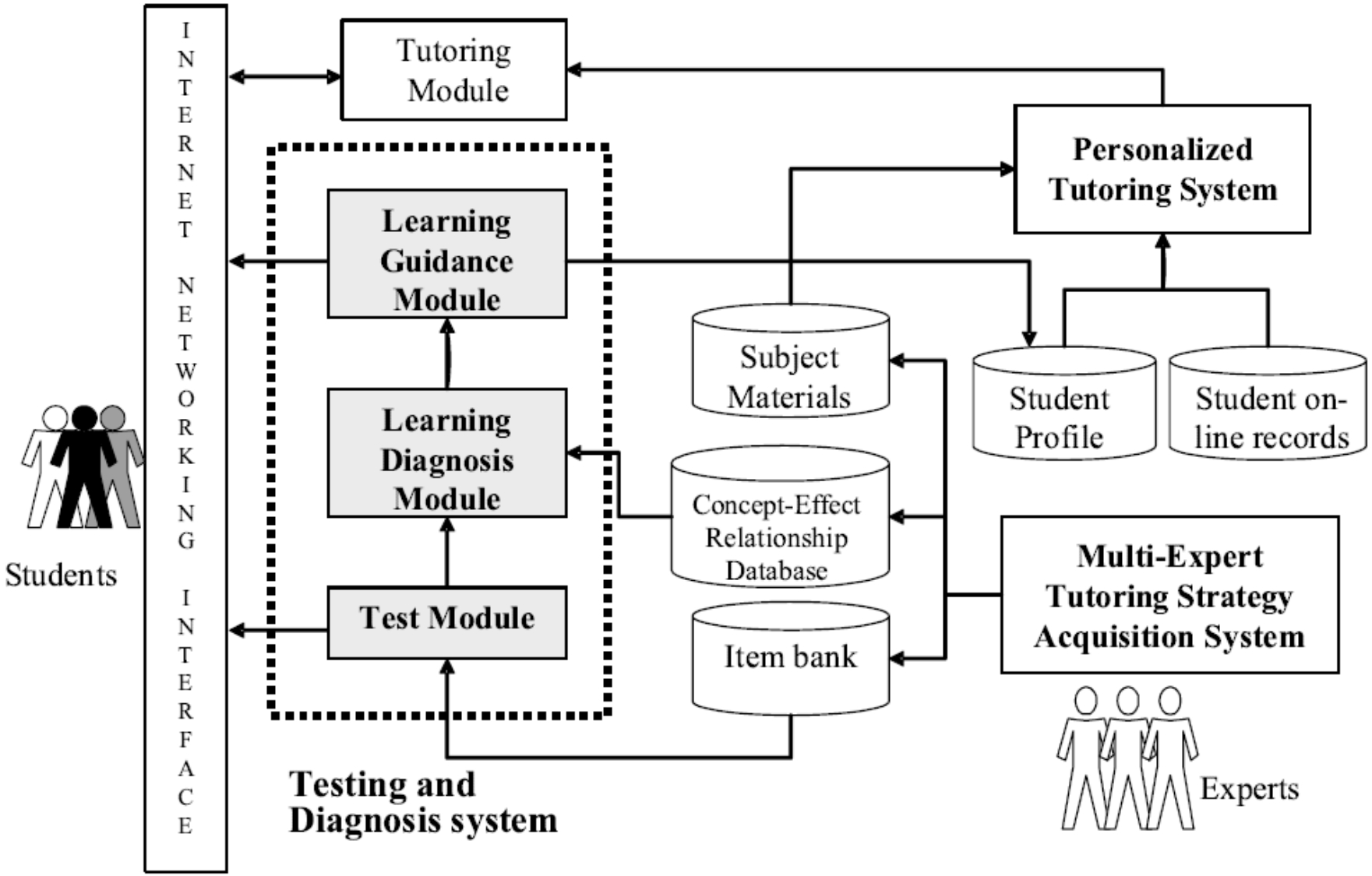
- To select the appropriate experimental teaching strategies and construct the specific virtual experiment.
- To provide the virtual experiment for students through a virtual experiment environment
- During the student's experiment, To provides real-time tracking for student’s operation and stepwise diagnosis, identify problems and give timely guidance.
- To reconstruct the virtual experiment. Again provide to students. Thus, the process of an intelligent guidance of the experiment was completed.



Li, et al.'s (2010) ITS based on Multi-agent



Cheng et al. (2014) 's MITS architecture



Hwang et al. (2008)'s ITED II

Inclusion criteria

- Reported original data.
- Samples were taken from Asia.
- Compared learning outcomes from ITS learning environment with outcomes from a non-ITS learning environment
- Sufficient quantitative data was presented to calculate effect sizes. Articles, in which the sample size for each group was not cited, were excluded.

Coding of study features

- Grade level: Elementary School (1-6), or Secondary School (6-9), or High-school (10-12), or Undergraduate.
- Types of Asian country: Developed, or Developing.
- Subject domains: Mathematics, or Earth Science, or Computer Programming, or Others

Coded information of selected studies for meta-analysis

Study	Sample size	Effect size	Grade level	Subject domains	Type of Asian Country
Abu-Naser (2009)	62	0.686	Undergraduate	Computer Programming	Developing
Bulut Özek, Akpolat, and Orhan (2013)	108	1.907	Undergraduate	Computer Programming	Developing
C.-M. Chen (2008)	220	-0.217	Elementary	Mathematics	Developed
L.-H. Chen (2011)	145	-0.616	Undergraduate	Computer Programming	Developed
T. C. Chien, Yunus, Suraya, Ali, and Bakar (2008)	62	1.684	Secondary	Mathematics	Developing
Huang (2010)	72	-0.003	High-school	Earth Science	Developed
Hwang, Tseng, and Hwang (2008)	76	0.746	High-school	Mathematics	Developed
Keun-Woo, EunKyoung, and YoungJun (2010)	115	-0.222	High-school	Computer Programming	Developed
Regalado et al. (2015)	27	1.011	NA	Others	Developing
Rodrigo et al. (2012)	126	0.159	High-school	Mathematics	Developing
Wang, Rosé, and Chang (2011)		-0.264	High-school	Earth Science	Developed
Yang, Leung, Yue, and Deng (2013)	52	2.217	Undergraduate	Others	Developing

Results

Overall effects

	k	*ES*	*SE*	Variance	95% Confidence interval		Test of mean		Test of heterogeneity in effect sizes		
					Lower	Upper	*Z*	*p*	Q-value	df(Q)	*p*
Fixed	12	0.229	0.066	0.004	0.1	0.359	3.474	0.001	113.6	11	0.000
Random	12	0.570	0.233	0.054	0.114	1.026	2.447	0.014			

***p*<.05**

Overall weighted effect size is +0.570, with a 95% confidence interval of 0.114-1.026.

The learning-achievement effect sizes of categories and their related moderator variables

Category	*k*	*g*	*z*	95% CI	Q_B
Grade level					52.10*
1.Elementary school	1	-0.217	-1.968*	[-0.434,-0.001]	
2.Secondary school	1	1.684	5.996*	[1.133,2.234]	
3.High-school	5	0.129	0.63	[-0.273,0.532]	
4.Undergraduate	4	1.031	1.598	[-0.230,2.255]	
Types of Asian country					11.77*
1.Developed country	6	-0.099	-0.507	[-0.483,0.284]	
2.Developing country	6	1.223	3.685*	[0.572,1.873]	
Subject domains					6.725*
1.Mathematics	4	0.561	1.515	[-0.615,1.287]	
2.Computer Programming	4	0.401	0.860	[-0.513,1.314]	
3.Earth science	2	-0.204	-0.566	[-0.912,0.503]	
4.Others	2	1.562	2.599*	[0.384,2.740]	

***p*<.05**

Summary of Meta-analysis

- Overall effect of ITS is better than the traditional mode of learning or not using ITS as an intervention, with a moderate effect size of 0.570.
- Analysis of moderator variables showed that ITS have been used to various grade levels, types Asian country and subject domains.
- The effect was greater for developing countries than developed countries.
- Novelty effect may be the reason for better performance of ITS in developing countries than developed countries.

Why is this so?

- Many schools in developing countries still lack infrastructure—electricity, telecommunications, and computer hardware (Nye, 2015)
- Within-country differences are also stark. Urban areas adopt technology quickly, while remote areas cannot (UNESCO Institute of Statistics, 2014).
- Lack of infrastructure is the lack of culturally-appropriate content (Nye,2015)
- ITSs tend to be built in Western, industrialized, educated, rich, developed (WEIRD) countries (Blanchard, 2012).
- Language and culture (symbols, contexts, situations, motivations) of the ITSs may not be a good fit for the target country's students.
- Student's lack of technology skills

Opportunities for future research

- Need to develop ITS beyond universal subjects
- ITSs should also be designed for deployment on mobile phones and tablets, technologies that are far more ubiquitous than personal computers.
- Attempt to maximize battery life by not being graphics-heavy and by minimizing the use of device components such as the camera, GPS, and accelerometer.
- Deployment of already existing successful ITS
- Effects of deployed ITSs should be monitored and studied.
- Investigate the cross-culture influences

Gamification

Games Keeps Children Engaged for Hours

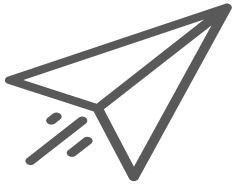
- Design Right - Elements of Interest for a Good Game
- Experience Design - Exploration, Hunting, Adventure, etc

What is Gamification?

Application of game-design elements and game principles in non-game contexts

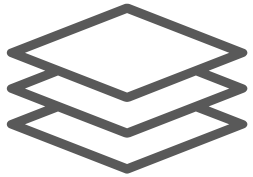
- Benefits
  - Socialization
  - Learning
  - Competition
  - Achievement
  - Reward
- Digital Content
  - Interactive Learning
  - Beyond the classroom
  - Tracked content
  - Another angle

Mechanics



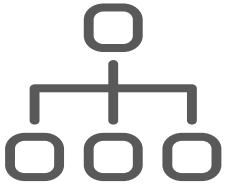
Fast Feedback : Immediate feedback or response to actions

Encourage users to continue or adjust their activities with onscreen notifications, text messages or emails.



Transparency : Where everyone stands

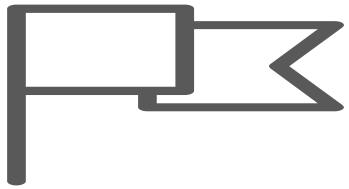
Show users exactly where they stand on the metrics that matter to you and to your audience.



Goals : Short term and long term

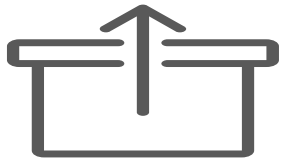
Missions or challenges give users a purpose for interaction, and educate users about what is valued and possible within the experience.

Mechanics



Badges : Evidence of accomplishments

An indicator of accomplishment or mastery of a skill is especially meaningful within a community that understands its value. Often used to identify skills and expertise within a group.



Leveling up : Status within the community

Levels indicate long-term or sustained achievement. Used to identify status within a community and to unlock new missions, badges, activities, and rewards.

Onboarding : An Engaging and compelling way to learn

Video games train you how to play as you play – users learn by doing. Simple missions help new users become engaged immediately as they master basic tasks, rather than being stumped by an unfamiliar interface or a detailed manual.

Mechanics

Points: Tangible, measurable evidence of my accomplishments

Used to keep score and establish status or accumulated to purchase virtual or real goods. Earn points through activities, sharing, contributing, or by creating something useful to others.

Community: A context for achievement

Community gives meaning to goals, badges, competitions, and other mechanics. Sharing participant achievements creates energy in the community by making people aware of what others are doing. They learn about goals, badges, and rewards that they may want to pursue.

Competition: How I'm doing compared to others

Raise the stakes for accomplishing a goal by showing users how they compare to others, as individuals or in teams. Encourage competition with time-based, team and individualized leaderboards. Where do I rank? How can I overtake my closest competitor?

Collaboration: Accomplish a goal working with others

Connect users as a team to accomplish larger tasks, to drive competition, and to encourage knowledge sharing. Show team members how they are contributing to the group's success. No one wants to let down their team members.

Game Mechanics	Game Dynamics	Competition	Collaboration	Community	Collection	Achievement	Surprise	Progress (emotional)	Exploration
	Points					●		●	
	Levels	●			●	●		●	
	Missions (individual & team)	●		●		●	●		●
	Badges			●	●	●	●	●	●
	Leaderboards (individual & team)	●	●	●		●			
	Unlocks					●	●		●
	Events Feed	●	●	●				●	●
	Notifications			●				●	
	Quiz	●		●		●		●	
	Progress (visual)					●		●	