The Self-Regulated Learning in Cognitive, Interactive, and Transparent Teaching Interface

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***Abstract*—The autonomy support and structure are two essential dimensions of self-determination. This paper proposed a mechanism, Cognitive, Interactive, and Transparent Teaching Interface (CITTI), which maintain the ways of autonomy structure and support for teachers to promote self-regulation learning with autonomy support and structure of self-determination processes. Participants were 31 junior high school learners (grade 7, 12~14 years old, 16 males, 15 females). To make learning visible and sensible is an essential mechanism for teaching generation and learning regulation in initiative thinking, sensing, perceiving, and action to explore, monitor, govern, and support the learning and teaching processes. The cognitive, interactive, and transparent teaching interface is both the a framework which is driven by the needs of users, and an architecture which is constructed by the perceptions of instructor to control, share, and distribute suitable information to suitable users.**

***Index Terms*—self-regulation, cognitive, interactive, and transparent teaching interface, supporting social architecture, making learning visible**

I. Introduction

In practice, we see the gaps between teaching and learning in concept comprehension and skill application during mathematical teaching and learning processes. The self-regulation is an instructional mechanism to promote the learning and teaching performance. Zimmerman & Martinez-Pons [1] proposed that a critical to school success is how teacher can promote self-regulated learning [2]. The self-regulation learning perspective takes a much more inclusive perspective on student learning which include cognitive, affective, and social contextual factors [3]. And Winne [4] highlighted the self-regulation learning would not take place automatically. Accordingly, what are the ways to build an environment, which are likely to satisfy individual's need for competence, and how to construct a structure for learning with autonomy support with self-feedback and self-retroaction. Furthermore, most of good performances of teaching and learning outcomes are based on the suitable information management and communication during the teaching and learning processes. And communicating is vital for developing mathematical ideas, for challenging misconceptions and improving the skills of reasoning. The educational processes are a series of information communications and interactions among instructors, learners, and objectives via suitable instructions, manipulations, and evaluations. And demands and knows appropriate representations for a specific mathematical concept will deploy the learning objects with precision and bridge between instructors' and learners' understanding. The precision and bridge behaviors are identified by well-defined programs, real teaching/learning actions and the detectable/reachable interaction processes between instructors, learners and concept frameworks. However, many instructors are both anxious and puzzled as they tried to make sense of the learning phenomena during invisible learning processes which become a black box that was not the real subjects can be insight and exploration. The phenomena include how learning performances are, what learners know or do not know, what concepts learners already have that can be the base for next concepts, and how instructors can access the information during teaching/learning processes. Accordingly, instructors and learners both need the efficient ways to communicate their main idea and cognition more transparently and directly. While learning is happen, the Cognitive, Interactive, and Transparent Teaching Interface (CITTI) [5] tries to transform the individual thinking and cognition into the visible features transparently.

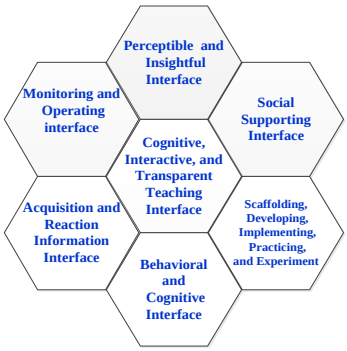

Figure 1. The six features of cognitive, Interactive, and transparent teaching interface

Meanwhile, CITTI constructed a structure for giving the transparent environment for learning and teaching with autonomy support in self-monitoring, self-evaluation, self-feedback, and self-regulation to enhance teaching and learning performances. The features of the CITTI are the follows: 1) perception and insight interface; 2)

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monitor and operation teaching and learning conditions; 3) acquisition and reaction information; 4) behavioral and cognitive interface; 5) scaffold, development, implement, practice, and monitor the interactive actions; 6) Supporting social architecture; The figure 1 illustrates the features of CITTI.

The scenario **'Manipulated Coordinate Planes Teaching/Learning Module' (MCPTLM)** is the experiment of the CITTI. Information management of CITTI is the strategies which are driven by the interactions of instructors and learners, and an architecture which is constructed by related pedagogical and psychological theories to handle, control, share, and distribute suitable information to guide and react teaching and learning processes. Accordingly, CITTI builds the visible and insightful ways for learners to construct and comprehend their knowledge and for instructors to evaluate and adjust their strategies. Consequently, the learners are not passive information/knowledge receivers, but also as information/knowledge constructors. Meanwhile, reciprocal teaching and learning processes which involve meta-teaching and meta-learning processes will be co-constructed by instructors and learners.

II. Instructional-Design of CITTI

In perspective of instructional design, the main purpose is to foster cognitive learning which involves 1) Clear information; 2) Thoughtful practice; 3) Informative feedback; 4) Strong intrinsic or extrinsic motivation [6]. Furthermore, the methods of the instructional design are the methods which were offered and adapted in situational rather than universal accesses. In this perspective, the suitable instructional design means that the methods will be accessed by the necessary of the processes which combined the critical characteristics among learner, objective, and instructor. Methods do not always belong to specific learner, objective, or instructor but it related to the characteristics of learner, objective, and instructor to reach the goals. In CITTI, the instructional design maintains the visible environment to enhance learning support via implicit and explicit ways to lead learning processes to go further and easily. The social support mechanisms include the instruction from teacher and the expression from the classmates. Table I illustrates the social supports from instruction and environment in explicit and implicit ways.

TABLE I. The Implicit and Explicit Supports Are Generated Maturely via the Structure of CITTI

Instruction / Environment	Support	Non-support
support	Implicit and explicit	Implicit
Non-support	explicit	None

The explicit support mechanisms will be instructed by teacher what concepts are and how to draw and express the visual presentation. And the implicit support mechanisms will be generated by classmates while learners drew and expressed the concepts on the ground individually. Accordingly, the CITTI fulfills the criterions of Perkins' instructional design [6] as the following: 1) Clear information: The descriptions and examples of the goals, knowledge needed, and the performances expected are implemented by instructor but co-constructed by instructors and learners via the CITTI. 2) Thoughtful practice: individual learners were asked to point, draw, and practice the concepts from step by step practices to whole applications. After learners practicing and drawing the operable concepts, they can compare to the neighborhood of individuals to evaluate individuals' learning outcomes. Whatever the results that learners made, the initiative thinking and learning processes will be happened and the thoughtful drill and practice will be occurred meanwhile. The CITTI maintains the opportunities for learners to engage actively and reflectively in social supporting learning environment. 3) Informative feedback: The CITTI maintains essential architectures and mechanisms of information management and feedback with clear, thorough counsel form instructors and learners to individual learners about their performance, helping them to proceed more exactly and effectively. 4) Strong intrinsic or extrinsic motivation: Activities of CITTI that are plentiful amply rewards to individual learners, either because they are very interesting and engaging in learning processes or because they feed into drawing or practicing achievements under the dynamic learning power of learning groups. Consequentially, the more learning outcomes we want to achieve, the more essential architectures and mechanisms of information management and communication we need to construct. The visible features of CITTI interface are the follows: 1) Perceptible and insightful interface: CITTI maintains the ways which are not only perceptible learning outcomes, but also insightful learning processes. The interface will provoke some contrasts among individuals, learners and instructors. Learners have chances to find the differences and mistakes of the expressions between individual and in the neighborhood of learner perceptively. 2) Monitoring and operating teaching and learning conditions: The interface supports the ways to communicate information transparently between instructors and learners. Instructors and learners can monitor and operate the teaching and learning actions via this interface. 3) Acquisition and reaction information: If critical information can be caught by instructors, and then it can be transferred and transformed into the teaching resources. These teaching resources are more meaningful than the materials which are identified by teaching programs. These teaching resources are more sensible and clear for learners to cogitate because these teaching resources were generated by learners themselves. Furthermore, if instructors can use the information suitably, then these information will be recognized and receipt sensibly and easily by learners to modify or discover their misconceptions. 4) Behavioral and cognitive interface: learners can learn and cogitate by actions, learning by experiences, and the instructors can use this interface to reorganize the teaching resources to enhance the learning outcomes. 5) To scaffold, develop, implement, practice, and monitor the interactive actions.

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This interface CITTI can scaffold, develop, implement, practice the courses and monitor the interactive learning and teaching processes. 6) Supporting social architecture: the supporting learning environment of CITTI is constructed by learners and instructors. The supporting mechanisms include assisting learning behaviors and stimulating learning motivations during learning processes. When learners pointed, graphed, drew, trod, and gestured on the coordinate concepts, they also simultaneously shared the information about what they known, what they saw, how to pointed, graphed, drew, trod, and gestured to react incremental adjustments via this transparent interface CITTI. The dynamic learning powers of learning groups which are the actions of teams and whole class will encourage or semi-force everyone to do the same thing in the same time. In addition, if most of learners do the same actions, these situations will stimulate the motivation and cooperation of learners effectively during learning processes. The teaching/learning processes will be monitored, realized, and recognized via this interface. Making learning visible, the communication ways of CITTI, is the key point to present, monitor, manage, and assist individuals during learning processes.

Figure 2. The cognitive, interactive, and transparent teaching interface will easily and transparently to observe and evaluate

III. Commitment, Control, and Confidence of CITTI

The commitment, control, and confidence are interacted each other in self-regulation [7]. Accordingly, the autonomy, self-control, self-monitor, self-discipline, and self-efficacy are implied to support the learners to reach specific objectives with self-generate thinking, feeling, acting, monitoring, and evaluating processes. Furthermore, Pintrich [8] proposes four assumptions of self-regulation learning models as the followings: 1) active, constructive assumption; 2) potential for control assumption; 3) goal, criterion, or standard assumption; 4) activities are mediators between personal and contextual characteristics and actual achievement or performance. And the cognitive evaluation theory proposes when fulfills the basic psychology needs, competence and autonomy, as well as motivates intrinsic motivation to active participants in the learning process [9]-[12] The researches [11], [12] shows that more autonomy supportive was built, the more intrinsic motivation was created. The intrinsic motivation perspective asserts that learners can potentially monitor, control, and regulate certain aspects of their own cognition, motivation, and behavior with curious, preferring challenges, and making independent mastery attempts. In CITTI, the interactions of commitment, control, and confidence will involve instructor, learner, and environment perspectives. The interface CITTI maintains the interaction mechanisms for information commitment in multiple directions which commitment directions are from instructor to learners (Fig. 2), learners to instructor (Fig. 3), groups to individual (Fig. 5), ground figures to individuals (Fig. 6), ground figures to instructor (Fig. 7), neighborhood classmates to individual learner (Fig. 4) and groups to instructor (Fig. 8).

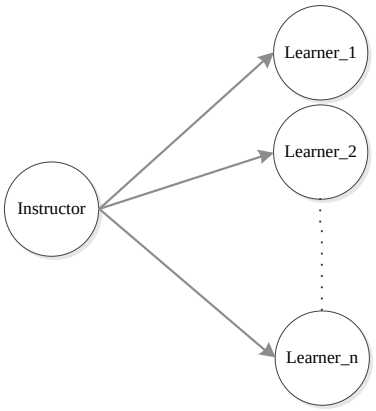

Figure 3. The information directions from instructor to learners

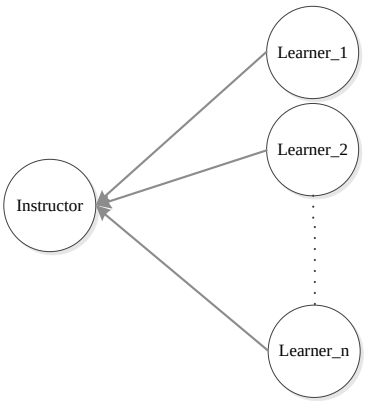

Figure 4. The information directions from learners to instructor

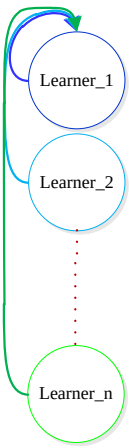

Figure 5. The information directions from neighborhood classmates to individual learner

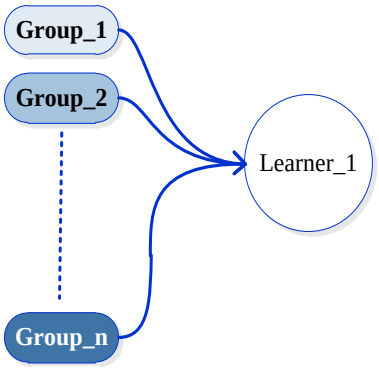

Figure 6. The information directions from groups to individual learner

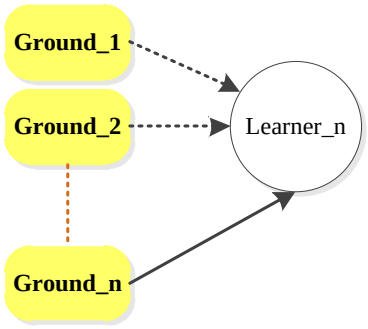

Figure 7. The information directions from ground figures to individual learner

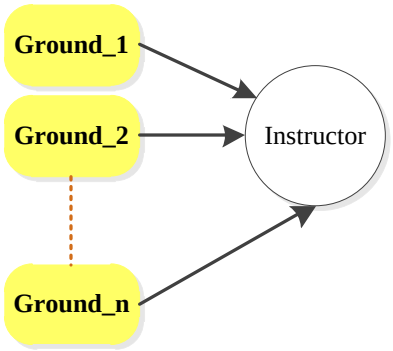

Figure 8. The information directions from ground figures to instructor

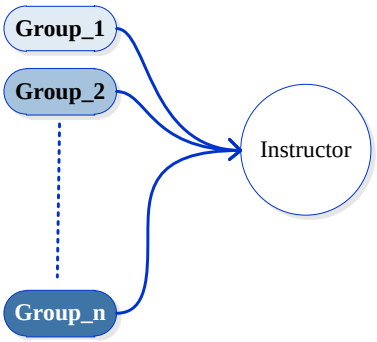

Figure 9. The information directions from groups to instructor

IV. Beyond Autonomy Interactions

Goals will be effective while learners share a commitment to reach goals which learners may easily to seek and receive feedback [13]. The commitment can be generated by figures, peers, groups, and competition authentications, role models, public statements about intentions, incentives, rewards, and general valence [7], [14]-[17]. The interface CITTI maintains the interaction mechanisms for information commitment in multiple directions which commitment directions are instructor to learners, groups to individuals, ground figures to individuals, ground figures to instructors, neighborhood classmates to individual learners. They monitored and modified each other via the interface of CITTI. Furthermore, instructors usually posed the questions for learner, but they usually did not detect and realize the situations of learners' solving and answering processes. The transparent expressions of solving and answering processes will give instructor and learner the detectable ways for understanding, monitoring, sharing, retroacting, and recognizing the teaching and learning information. The ways are not only for instructors to make sense to generate next instructions, but also for learners to understand their cognition and metacognition to make self-regulation. In other words, the visible and sensible expressions are both objects of teaching and learning outcomes and feedbacks for generate future teaching and learning phenomena. Beyond the CITTI learning processes, the autonomy support and structure are motivators for instructor's and learner's self-inspiring, and self-regulating.

TABLE II. The Cognitive Types and Cognitive Integration Styles Are Generated Naturally via the Structure of CITTI

Cognition / type / cognitive integration	Routine	Adaptive
Dependent	Surface Effecting	Surface Realizing
Independent	Deepen Effecting	Deepen Realizing

V. Adaptive and Routine Cognition

The routine to adaptive cognition will induce the knowledge applications in procedural to conceptual knowledge while apply the knowledge suitably, adaptively, and correctly. The mental model [18], conceptual knowledge, of individuals will simulate, predict and explain the familiar or unfamiliar objects to extend individuals' experiences and go beyond environment setting. Learner and instructor can comprehend and construct different conceptual knowledge according to internal interactions among of individual's cognition, metacognition, and knowledge acquisition, and external interactions among of expression, instructor, learner, and environment. The different of two cognition types, adaptive and routine cognition, are based on the realizing or effecting oriented conspicuous recognition and application. The differential of realizing or effecting oriented is with or without constructing or enriching individual conceptual knowledge framework. Furthermore, instructors and learners may construct different conceptual knowledge that base on individual's availability and conspicuousness of already existing cognitive models. The cognitive types

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and cognitive integration styles are illustrated in Table II to show the interactions between environment and cognition. CITTI maintains the transparent interface for giving the possible channels for instructors and learners to make sense and evaluate their performances which are teaching and learning effects.

In adaptive learning and teaching processes, the more autonomy support and structure will lead better learning outcomes. However, the differential teaching and learning structures will lead to differential teaching and learning effects. The effects were not merely to understand the surface meanings and skills for passing and reaching the learning objectives by regular or routine thinking and processing, but also to develop the possible meanings and skills for evaluating and creating possible thinking and processing into high order and creative thinking to build specific knowledge. The values of CITTI are created the fundamental and transparent environment to interact essential information (cognition, metacognition, application and modification) which generates by individual objects (instructor, learner). Evidently, individual may effective thinking and cognizing while individuals sense about learning and teaching then the self-evaluating, self-negotiating, and self-constructing to adapt and internalize individual's knowledge. CITTI maintains cognitive development processes for the spontaneous teaching and learning experiences to go further easily and confidently.

VI. Methods, Experiments and Conclusions

A. Participants and Design

Participants were 31 Taiwan junior high school students (15 female, 16 male; age M＝12.71, SD＝ 0.588) in their first year of junior high school education from a single class and school in the north part of the Taiwan. All participants were not used to be taught by the instructor of CITTI. And the courses, Coordinate Planes, had not been taught and learned before courses of CITTI. The pretest score showed M＝30.81 and SD＝12.787)

B. Environment Setting

The initial stage is to distribute the class into 6 groups with the heterogeneous distribution. After the distribution, the classroom was empty without any desks and chairs. Next, each group was arranged in straight lines, and each learner had three colors of chalks and a whole plane (60 cm×60 cm) on the ground.

C. Course Description

The scenario, **'Manipulated Coordinate Planes Teaching/Learning Module' (MCPTLM),** is the experiment of the CITTI. The intent of the MCPTLM was to stimulate motivation and actions of learners with the mathematical ideas in concept-oriented actions, including creating opportunities for visualization in learning performances, identification in learning actions, and recognition the learning situations while transfer or extent to another learning concepts and misunderstood concepts. Accordingly, the MCPTLM maintains the ways that teacher can be confident on the learning phenomena and the potential for meaningful review after the action itself during the interim steps. We conducted our study in junior high students. The mission statements of the teaching objectives and subordinated objectives of coordinate planes are identified in teaching programs.

VII. Experiments

Experiment 1 aimed to investigate whether the interface was effected learners' interest positively. Table III illustrates that CITTI affected on individuals' understand degree during teaching and learning interactions. The sum of the percentage of completely and mostly understanding is 93.55% that expressed learning effects was positive while maintained autonomy support and structure for individuals to make sense and evaluate their learning processes and learning outcomes. Beyond the experiment 1, we can make sure the information communication will clear to connect instructor and individual learner in transparently and confidently cognitive processes. Table III illustrates that CITTI affected on individuals' understand degree during teaching and learning interactions.

TABLE III. CITTI Affected on Individuals' Understanding Degree during Teaching and Learning Interactions

Understand degree	Percentage
Completely understanding	48.39%
Mostly understanding	45.16%
Partially understanding	6.45%
No understanding	0.0%

TABLE IV. CITTI Affected on Individuals' Concentration Degree during Teaching and Learning Interactions

Concentration degree	Percentage
Completely concentration	22.58%
Mostly concentration	61.29%
Partially concentration	16.13%
No concentration	0.0%

Experiment 2 aimed to investigate whether the interface was effected learners' concentration degree via the interactive operations of CITTI. Table IV illustrates that CITTI affected on individuals' concentration degree during teaching and learning interactions. The sum of the percentage of completely and mostly concentration degree is 83.87% that expressed learning effects was positive on learners' concentration degree while maintained interactive support and structure for individuals to follow, operate, activate, and modify their learning situations and learning outcomes. Beyond the experiment 2, we know the interactive and actionable behaviors with transparent communication will clear to interact the concept operations, teaching strategies and learning actions in interactively, transparently and autonomously cognitive processes. Accordingly, concepts, instructors, and individual learners will base on the constructive activities to construct their works via interactively, transparently and autonomously cognitive processes in dynamics of the CITTI learning groups. Table IV illustrates that CITTI affected on individuals'

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concentration degree during teaching and learning interactions.

Experiment 3 aimed to investigate whether the interface was effected learners' interest positively. Table V illustrates that CITTI affected on individuals' interest degree during teaching and learning interactions. The percentage of Increase interest degree is 70.97% that expressed learning effects was positive on learners' interest degree while maintained transparent, interactive and autonomic support, structure, and communication for individuals to realize, learn, operate, activate, and modify their learning situations and performances. Beyond the experiment 3, we know the cognitive, interactive, transparent, and actionable behaviors with transparent communication will clear to increase the interests of individual learners in cognitively, interactively, transparently and autonomously cognitive and metacognitive processes. Accordingly, dynamics of the CITTI learning groups will benefit on individuals' constructive activities to construct their works via interactively, transparently and autonomously cognitive processes. Table V illustrates that CITTI affected on individuals' interest degree during teaching and learning interactions.

TABLE V. CITTI AFFECTED ON INDIVIDUALS' INTEREST DEGREE DURING TEACHING AND LEARNING INTERACTIONS

Interest	Percentage
Increase interest	70.97%
No effectiveness	29.03%

The dynamics of groups will have the chances for individuals in feeling of belongingness, security, acceptance, prestige, and confidence [19], [20] in social activities. Consequently, the CITTI maintains interactive mechanism, social supporting environment, feedback functionality, detectable and visible learning processes, and suitable teaching strategies which will interact concept operations, teaching strategies and learning actions in interactively, transparently and autonomously cognitive processes. The interface of CITTI maintains the interactive ways to give the cognitive channels and to build sensory experience and evidence perception for individuals to manipulate the mathematical learning concepts. The features of the interface are the follows: 1) Perception and insight interface: The interface maintains the ways to insight into learning processes. The interface will provoke some contrasts between individual with learners and learners with the instructor. Learners have chances to find the differences and mistakes between individual and their classmates perceptively. 2) Monitor and operate teaching and learning conditions: The interface supports a way to communicate information transparently between instructors and learners. They can monitor and operate the teaching and learning conditions via this interface. 3) Acquisition and reaction interface: The critical information which can be caught by instructors and learners that can transport and transform the critical information into useful teaching resources. These teaching resources are not merely much more meaningful than the teaching content which is identified by instructors during teaching processes but also more sensible and clear than the learning content for learners to cogitate because these teaching resources were generated by learners themselves. Furthermore, if instructors can use the information suitably, then these information will be recognized and receipt sensibly and easily by learners. 4) Reusable and cognitive interface: the instructors can use this interface to reorganize the teaching resources to modify and reuse the interface. This interface, CITTI, can scaffold, develop, implement, practice the courses and monitor the interactive learning and teaching processes. The teaching/learning actives will via this interface to be insight, realized, and recognized teaching and learning outcomes.

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