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Predictors of Academic Achievement of Student ICT Teachers with Different Learning Styles

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***Abstract*—**The main purpose of this study was to determine the predictors of academic achievement of student Information and Communications Technologies (ICT) teachers with different learning styles. Participants were 148 student ICT teachers from Ankara University. Participants were asked to fill out a personal information sheet, the Turkish version of Kolb's Learning Style Inventory, Weinstein's Learning and Study Strategies Inventory, Schommer's Epistemological Beliefs Questionnaire, and Eysenck's Personality Questionnaire. Stepwise regression analyses showed that the statistically significant predictors of the academic achievement of the accommodators were attitudes and high school GPAs; of the divergers was anxiety; of the convergers were gender, epistemological beliefs, and motivation; and of the assimilators were gender, personality, and test strategies. Implications for ICT teaching-learning processes and teacher education are discussed.

***Keywords*—**Academic achievement, student ICT teachers, Kolb learning styles, experiential learning.

I. Introduction

For many years, educational researchers have maintained an interest in the effective prediction of students' academic achievement at school. The prediction and explanation of academic achievement and the examination of the factors relating to the academic achievement are topics of greatest importance in different educational levels. Studies have shown that prior academic performance is an important predictor of performance at other levels of education [1]. Similarly, cognitive ability was found as the strongest predictor of academic performance [2]. However, some studies confirm that the correlation between cognitive ability and academic performance tends to decline as students progress in the educational system [3]. Thus, many researchers have emphasized the need to include non-cognitive factors such as personality, motivation, learning strategies and beliefs in investigations of individual differences in academic achievement. In other words, contemporary researchers are interested in whether or not other individual differences than cognitive ones (for example; intelligence, cognitive ability) may be used to predict academic achievement. The present study aims at determining the predictors of academic achievement of student ICT teachers (formerly called computer teachers) with different learning styles. Because some researchers have suggested that learning styles are related to culture [4], [5], and are discipline specific [6], we preferred to examine the predictors of academic achievement of student ICT teachers with different learning styles separately in the Turkish culture.

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Experiential Learning Theory and Learning Styles

"Experiential Learning Theory (ELT) defines learning as the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience. The ELT model portrays two dialectically related modes of grasping experience—Concrete Experience (CE) and Abstract Conceptualization (AC) (perception mode)—and two dialectically related modes of transforming experience—Reflective Observation (RO) and Active Experimentation (AE) (information-processing mode). Experiential learning is a process of constructing knowledge that involves a creative tension among the four learning modes that is responsive to contextual demands. This process is portrayed as an idealized learning cycle or spiral where the learner "touches all the bases"—experiencing, reflecting, thinking and acting—in a recursive process that is responsive to the learning situation and what is being learned." [7]. Learning is conceived as a four-stage cycle in this model (see Fig. 1).

"The learners, if they are to be effective, need four different kinds of abilities: Concrete Experience abilities, Reflective Observation abilities, Abstract Conceptualization abilities, and Active Experimentation abilities. That is, they must be able to involve themselves fully, openly, and without bias in new experiences (CE); they must be able to observe and reflect on these experiences from many perspectives (RO); they must be able to create concepts that integrate their observations into logically sound theories (AC); and they must be able to use these theories to make decisions and solve problems (AE)." [8].

According to Kolb and Kolb [7], the concept of the learning style describes individual differences in learning based on the learner's preference for employing different phases of the learning cycle. Learning styles also refer to cognitive, affective, and physiological behaviors that perform as

relatively stable indicators of how people perceive, interplay with, and respond to their environment in learning situations [9]. Reference [10] defines learning styles as "individual consistencies in perception, memory, thinking, and judgment across any stimulus condition."

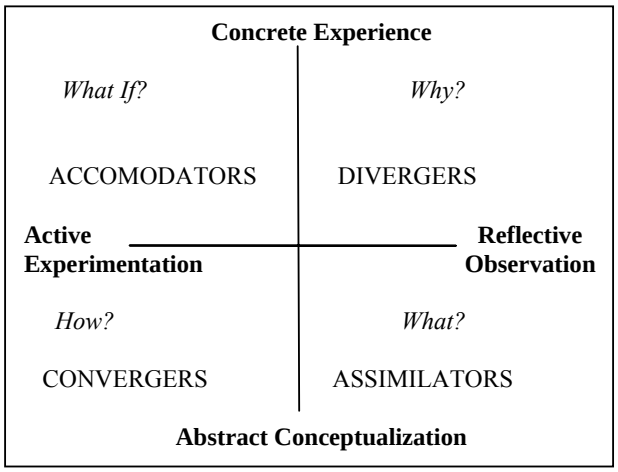

Fig. 1 Kolb's Experiential Learning Cycle and Learning Styles

"*Accommodators* are best at Concrete Experience and Active Experimentation. Their greatest strength lies in doing things, in carrying out plans and experiments and becoming involved in new experiences. Educational backgrounds of accommodators are often in technical or practical fields such as business, marketing, sales, finance, accounting, education, and communication." [8].

"*Divergers* are best at Concrete Experience and Reflective Observation. Their greatest strength lies in imaginative ability. Educational backgrounds of divergers are often in social sciences or humanities (history, political science, language, sociology, economics, philosophy, etc.) and liberal arts. Counselors, organizational development consultants, and personnel managers often have this learning style." [8].

"*Convergers* are best at Abstract Conceptualization and Active Experimentation. Their greatest strength lies in the practical application of ideas. Educational backgrounds of convergers are often in the physical sciences and technology. Engineers and computer scientists often have this learning style." [8].

"*Assimilators* are best at Abstract Conceptualization and Reflective Observation. Their greatest strength lies in the ability to create theoretical models. Educational backgrounds of assimilators are often in the natural (basic) sciences such as physics, chemistry, biology, astronomy, and mathematics. Scientists, researchers and academics often have this learning style." [8].

Studies have shown that when learning style matches the demands of a given field of study or career specialization, higher performance results [11], [12]. Therefore, in this study, the following research question was addressed:

What were the significant predictors of academic achievement of student ICT teachers with different learning styles?

II. METHODS

A. Participants

A total of 148 student ICT teachers from Ankara University participated in the study. Of the participants 70 (47%) were females, 78 (53%) were males; 31 (21%) were freshmen, 30 (20%) were sophomores, 40 were (27%) juniors, and 47 (32%) were seniors. The mean age was 21.47 (SD=1.61; Minimum: 17; Maximum= 26).

B. Data Collection

Five instruments were used in this study. Participants' demographic information such as age and gender were obtained using open-ended questions. Participants' university GPAs (Grade Point Average) were obtained from the records of the Student Affairs Bureau of the Faculty of Educational Sciences. Table I shows the number of items and Cronbach's alpha internal consistency coefficients of the instruments used in this study.

TABLE I
ITEM NUMBERS AND CRONBACH'S ALPHA INTERNAL CONSISTENCY COEFFICIENTS OF THE INSTRUMENTS

Instrument	Number of Items	Cronbach's Alpha
Kolb Learning Style Inventory	12x4	-
Concrete Experience		0.62
Reflective Observation		0.70
Abstract Conceptualization		0.70
Active Experimentation		0.63
Concrete-Abstract		0.73
Active-Reflective		0.74
LASSI (10 Sub-scales)	77	0.93
Attitude	8	0.64
Motivation	8	0.69
Time Management	8	0.79
Anxiety	8	0.79
Concentration	8	0.84
Information-Processing	8	0.83
Selecting Main Ideas	5	0.63
Study Aids	8	0.62
Self Testing	8	0.71
Test Strategies	8	0.70
EBQ (3 Sub-scales)	35	0.75
Factor 1 (Learning Depends on Effort)	18	0.82
Factor2 (Learning Depends on Ability)	8	0.54
Factor3 (One Unchanging Truth)	9	0.68
Eysenck Personality Questionnaire (Extroversion Sub-scale)	21	0.76

Participants' learning styles were measured using the Turkish version of Kolb's Learning Style Inventory (LSI) [13]; learning and study strategies were measured using the Turkish version of Weinstein's Learning and Study Strategies Inventory (LASSI) [14]; epistemological beliefs were measured using the Turkish version of Schommer's Epistemological Beliefs Questionnaire (EBQ) [15]; and extrovert-introvert personality orientation was measured using the Turkish version of Eysenck's Personality Questionnaire (EPQ-R) [16]. All of the Turkish versions of these scales were

proved as valid and reliable instruments.

C. Data Analysis

In addition to the descriptive statistics such as frequency, percentage, mean and standard deviation, and one-way ANOVA, to identify the variables that predict university academic achievement of the student ICT teachers with different learning styles, separate stepwise regression analyses were performed. This method helps to find the smallest possible set of predictor variables included in the regression model. Therefore, stepwise regression provides only the highest contributing variables as predictors.

III. FINDINGS

Table II shows the descriptive statistics of participants' learning styles and genders. As shown in Table II, and III, of the participants 51 (%34.5) were convergers, 49 (%33.1) were assimilators, 27 (%18.2) were divergers, and 21 (%14.2) were accommodators. The distribution of learning styles between males and females was also very similar. As it can be seen, the most common learning styles of student ICT teachers are *converging* and *assimilating* which both are said to be suited to careers in science and technology.

TABLE II
PARTICIPANTS' LEARNING STYLES AND GENDERS

Learning Styles	Female		Male		*Total*	
	n	%	n	%	n	%
Accommodators	10	48	11	52	21	100
Divergers	12	44	15	56	27	100
Convergers	27	53	24	47	51	100
Assimilators	21	43	28	57	49	100
Total	70	47	78	53	148	100

Table III shows the descriptive statistics of participants' learning styles and university GPAs.

TABLE III
PARTICIPANTS' LEARNING STYLES AND UNIVERSITY GPAS*

Learning Styles	n	%	GPA M	GPA SD
Accommodators	21	14.2	79.55	6.83
Divergers	27	18.2	80.95	5.08
Convergers	51	34.5	79.18	7.26
Assimilators	49	33.1	80.03	6.51
Total	148	100	79.84	6.56

*Maximum point: 100

As shown in Table III, participants' university GPAs in terms of their learning styles were M=80.95 for divergers, M=80.03 for assimilators, M=79.55 for accommodators, and M=79.18 for convergers, respectively. Interestingly, *divergers* outperformed assimilators, accommodators, and convergers, but the difference is not statistically significant [$F(3,144)=.450$, $p>.05$]. This finding is inconsistent with the finding of another study that showed the convergers and assimilators among Information Systems (IS) students performed better than the students with other learning styles [17]. In the same study, the divergers were found to be performing relatively poorly. Future studies should clarify the inconsistencies between the results of different studies.

Table IV shows the predictors of accommodators' academic achievement.

TABLE IV
PREDICTORS OF ACCOMODATORS' ACADEMIC ACHIEVEMENT

Predictors	B	SE_B	β	ΔR^2
Attitude	0.79	0.25	0.59**	0.35
High School GPA	6.13	2.38	0.42*	0.17

*p<.05, **p<.01

The statistically significant predictors of the accommodators' academic achievement were attitudes and high school GPAs. The total of the variance explained of the predicting variables was 52% (35% by attitudes and 17% by high school GPAs). The accommodators who have positive attitudes toward school and for succeeding in school, and have higher high school GPAs, are more successful in the university.

Table V shows the predictors of divergers' academic achievement.

TABLE V
PREDICTORS OF DIVERGERS' ACADEMIC ACHIEVEMENT

Predictors	B	SE_B	β	ΔR^2
Anxiety	-0.52	0.21	-0.44*	0.20

*p<.05

The only statistically significant predictor of the divergers' academic achievement was anxiety. The total of the variance explained of the predicting variable was 20%. The divergers who are not anxious when approaching academic tasks, in other words, those who are not paralyzed or distracted by debilitating anxiety, are more successful in the university than their anxious counterparts.

Table VI shows the predictors of convergers' academic achievement.

TABLE VI
PREDICTORS OF CONVERGERS' ACADEMIC ACHIEVEMENT

Predictors	B	SE_B	β	ΔR^2
Gender	7.55	1.75	0.52**	0.28
Epistemological Beliefs	-0.59	0.18	-0.37**	0.13
Motivation	0.42	0.19	0.24*	0.05

*p<.05, **p<.01

The statistically significant predictors of the convergers' academic achievement were gender, epistemological beliefs and motivation. The total of the variance explained of the predicting variables was 46% (28% by gender, 13% by epistemological beliefs, and 5% by motivation). According to the results, female convergers' academic achievement in the university (M=82.74, SD=6.34) was higher than their male

counterparts (M=75.18, SD=6.13); convergers who have flexible beliefs that learning strongly depends on ability are more successful in the university. In addition, the convergers who have higher motivation for succeeding in school are more successful than their low motivated counterparts.

Table VII shows the predictors of assimilators' academic achievement.

TABLE VII
PREDICTORS OF ASSIMILATORS' ACADEMIC ACHIEVEMENT

Predictors	B	SE_B	β	ΔR^2
Gender	7.18	1.58	0.55**	0.30
Personality	-0.47	0.19	-0.29*	0.08
Test Strategies	0.41	0.17	0.26*	0.07

*p<.05, **p<.01

The statistically significant predictors of the assimilators' academic achievement were gender, personality and test strategies. The total variance explained of the predicting variables was 45% (30% by gender, 8% by personality, and 7% by test-taking strategies). According to the results, female accommodators' academic achievement in the university (M=84.13, SD=5.20) was higher than their male counterparts (M=76.96, SD=5.69); in terms of their personality, introvert accommodators' academic achievement in the university (M=81.61, SD=6.76) was higher than their extrovert counterparts (M=77.75). Finally, accommodators who have more mature preparation strategies and test-taking strategies are more successful than their counterparts.

IV. DISCUSSION

This study addressed the statistically significant predictors of university academic achievement of student ICT teachers with different learning styles. Findings showed that the most common learning styles of the Turkish student ICT teachers were *Converging* (34.5%) and *Assimilating* (33.1%). This finding is consistent with many other studies' findings that attempted to determine the learning styles of student computer scientists, information system (IS) students, doctoral students majoring in Computing Technology in Education, and different learning style students' performance in computer literacy or programming courses [17], [18], [19], [20], [21]. This finding supports Kolb's assertion that persons in technology and computer/information sciences careers generally prefer these learning styles [22].

According to the findings of the study, the statistically significant predictors of the accommodators' academic achievement were attitudes and high school GPAs. Reference [7] asserts that accommodators' tendency may be to act on "gut" feelings rather than on logical analysis. Therefore, it is not surprising to see that the first significant predictor of university academic achievement of accommodators is positive attitudes toward school and for succeeding in school. On the other hand, the second significant predictor of university academic achievement of accommodators is high school GPAs, namely prior academic performance. The actual learning environments of high school and university could be appropriate for learning needs of accommodators. More clearly, accommodators are known as rely more heavily on people for information rather than on their analysis skills [7]. Thus, common lecture-oriented or teacher-centered learning environments of high schools and the higher-education institution may fit the expectations of accommodators that require information-provider teachers. However, this claim is speculative, therefore needs further examination.

The only statistically significant predictor of the divergers' academic achievement was anxiety. Divergers are interested in people and tend to be imaginative and emotional, have broad cultural interests, and tend to specialized in the arts and humanities [8]. People with diverging learning style are best at viewing concrete situations from many different points of view [7]. Learning anxiety has often been shown to be predictive of a poorer learning outcome [23]. For example, more anxious individuals attend to fewer environmental cues, encode information less well, process material less effectively, experience more cognitive interference, and lose working memory capacity by worrying [23]. The reason that anxiety was the only significant predictor of university academic achievement of divergers could be due to their creative and emotional nature. Namely, the emotional instability of divergers may lead to be anxiety-sensitive in learning and testing processes.

The statistically significant predictors of the convergers' academic achievement were gender, epistemological beliefs and motivation. People with converging learning style have the ability to solve problems and make decisions based on finding solutions to questions or problems. They prefer to deal with technical tasks and problems rather than with social and interpersonal issues [7]. For example, computer scientists or engineers often have this type of learning style. The possible reason that gender was the first significant predictor of university academic achievement of female convergers could be due to their very fitting departmental (discipline) choice. Therefore, it can be speculated that female convergers are more able to choose a field of study that appropriate for their learning style. However, this claim needs further examination. Another interesting finding of this study is to see that there are more female convergers than males. This finding is inconsistent with the findings of another study that found females tend to have diverging learning style while males tend to have converging learning style [24]. Similarly, reference [25] found that females tended to prefer concrete learning styles (accommodating and diverging), whereas males were more likely to opt for abstract conceptualization (converging and assimilating). Reference [26], on the other hand, found that females were slightly more reflective and abstract in their learning styles than men. However, the sample of this study related adoption of computers, and females tended to be more abstract in their learning styles in this sample, because of their field of study (sciences). This explanation could be valid for the findings of the present study, too. Further studies should examine gender differences and academic discipline choice

differences in learning styles in the Turkish context.

The second significant predictor of academic achievement of convergers was epistemological beliefs. Epistemological beliefs refer to the beliefs about the nature of knowledge and learning. The convergers who have beliefs that learning depends less on ability are more successful in the university. Studies have shown that science and engineering students often have naïve epistemological beliefs including the belief that the ability to learn is fixed at birth, therefore, cannot be improved [27]. On the other hand, same studies have shown that social sciences, humanities and arts students often have sophisticated/flexible epistemological beliefs. Reference [28] found that the Turkish student ICT teachers had naïve epistemological beliefs than student classroom and social studies teachers. The reason that epistemological beliefs was the significant predictor of university academic achievement of student ICT teachers who have converging learning style could be due to their strong technological orientation, and their preference to deal with technical tasks and problems rather than with social and interpersonal issues. Convergers are also known as close-minded that is the example of naïve epistemological beliefs. Future studies should focus on developing remedial training programs for science, technology and engineering students who have naïve epistemological beliefs.

The third significant predictor of university academic achievement of convergers was motivation. Reference [29] found that only the *motivation* sub-scale of LASSI was a consistent predictor of students' academic success. Motivation sub-scale of LASSI addresses students' diligence, self-discipline, and willingness to work hard. Students' score on this scale measure the degree to which they accept responsibility for performing the specific tasks related to school success [30]. Since the convergers tend to have narrow interests and tend to specialize in non-human fields such as science, technology and engineering, their intrinsic motivation may be more important than other factors. Future studies should investigate the sources of intrinsic motivation of students with different learning styles.

Finally, the statistically significant predictors of the assimilators' academic achievement were gender, personality and test strategies. According to the references [7] and [8], individuals with an assimilating learning style are less focused on people and more interested in ideas and abstract concepts. The assimilating learning style has been seen as important for effectiveness in information and science careers. The assimilators prefer readings, lectures, exploring analytical models, and having time to think things through [7]. The reason that gender was the first significant predictor of university academic achievement of assimilators could be due to age factor. A meta-analysis study [31] revealed that age was the only variable - which significantly correlated with learning styles, especially abstract conceptualization. More specifically, although Kolb [25] found that females tended to prefer concrete learning styles, above mentioned meta-analysis study showed that younger females in the university environment were more abstract than younger males. The present study supports this assertion. Almost the same number of females and males has abstract conceptualization modes of learning in the sample of the present study, and female assimilators' academic achievement in the university is higher than male assimilators.

The second significant predictor of academic achievement of assimilators was personality. In this study, student ICT teachers' personality was evaluated on a bipolar continuum (Extroversion vs. Introversion). The thinking and behavior that are directed inward or to oneself is known as introversion, whereas, the thinking and behavior that is directed outward or to the surrounding environment is known as extroversion [32]. Extroverts are sociable, friendly, seek affiliation, dislike complicated procedures, task-oriented, and desire excitement. Introverts, on the other hand, are more contemplative, reflective, conceptually oriented, seek academic achievement and academically superior. Interestingly, some researchers and educators use the terms *action-oriented* for extroverts, and *reflective-oriented* for introverts [32]. Extroversion is related to the concrete experience and active experimentation (accommodating) learning styles from Kolb's Learning Style Model, whereas introversion is related to the reflective observation (assimilating) learning style [32]. Therefore, it is not surprising to see that the personality type of assimilators predicted their academic achievement. More specifically, introvert assimilators are more successful than their extrovert counterparts. This finding is consistent with the findings of other studies that showed there were positive correlations between introversion and academic achievement and negative correlations between extroversion and academic achievement [33], [34], [35]. However, it is still unclear for us why personality did not predict academic achievement of individuals with other learning styles? Future studies should investigate this issue.

The third statistically significant predictor of the assimilators' academic achievement was test strategies. According to reference [30], effective test performance depends on both preparation strategies and test-taking strategies. Test preparation includes knowing about the type of test whereas test-taking strategies include knowing about the characteristics of tests and test items, and how to create an effective test-taking strategy [30]. Reference [36] found that higher education students with high academic achievement were significantly different from those with low academic achievement across various LASSI sub-scales including test strategies. They also concluded that test strategy was a useful variable to reflect students' academic performance, because a good test strategy can let students fully apply what they had learnt from the course in the examination. However, assimilators are less able to apply theories/models and integrate them into logical explanation, and they are also weak on qualitative or concrete tasks [32]. Therefore, it can be considered to be normal that the test strategies predicted academic achievement of assimilators. Future studies should re-examine predictors of academic achievement of students

with different learning styles in the contexts of test types (verbatim, comprehension, application, problem solving, etc.), disciplines (sciences, technology, social sciences, arts and humanities, etc.), and levels of education (elementary, secondary, higher education, etc.).

Reference [8] attempted to map different academic fields on Kolb's learning styles dimensions and a fourfold typology of disciplines emerged. In the abstract-reflective quadrant are clustered the *natural sciences and mathematics* (such as physics, chemistry, and biology), while the abstract-active quadrant includes the *sciences-based professions* (such as computer sciences and engineering). The concrete-active quadrant encompasses what might be called the *social professions* (such as education, psychology, and social work). The concrete-reflective quadrant includes the *humanities and social sciences* (such as art, sociology and journalism). As mentioned before, individuals who have educational background in computing or ICT field generally prefer converging and assimilating learning styles. Educators (teachers), on the other hand, typically prefer accommodating learning style. Educators' learning style preferences often imply a preference for certain teaching style which benefits some students while placing others at a disadvantage. A more desirable learning environment in the likelihood of learning preference diversity within a class would enhance and value equally all styles of learning [6]. Therefore, an ICT (or computer) teacher training program must combine the learning activities that enhance equally converging, assimilating, diverging and accommodating learning styles in order to lessen the possible instructional methods/strategies biases that can be stem from the faculties' own learning styles.

Suggested activities to each of Kolb's learning processes are shown in Table VIII.

TABLE VIII
ACTIVITIES THAT ACCOMMODATE KOLB LEARNING PROCESSES

CE	RO	AC	AE
Lecture	Thought questions	Lecture	Lecture
Problem sets	Brainstorming	Papers	Laboratories
Readings	Discussions	Analogies	Case studies
Films	Logs	Text readings	Homework
Simulations	Journals	Projects	Projects
Laboratories		Model building	Fieldwork
Observations		Model critiques	
Fieldwork			

Source: [25], [37]

In order to enhance learning environments for *convergers,* faculties should act as coach, and prefer to use lecture method, lab and case studies, demonstrations, homework, projects, model building and fieldwork. In order to enhance learning environments for *assimilators,* faculties should act as expert, and prefer to use lecture method, thought questions, textbook readings, papers, brainstorming sessions, discussions, projects, model buildings, independent research and journals. In order to enhance learning environments for *accommodators,* faculties should act as evaluators/remediators, and prefer to use lecture method, lab studies, problem sets, readings, films, design projects, student presentations and simulations. Finally, in order to enhance learning environments for *divergers,* faculties should act as motivator, and prefer to use lecture methods, problem sets, motivational stories, group discussions and projects, readings, films, simulations, brainstorming sessions, and field trips. According to Kolb [25] [38], by teaching through the Kolb Learning Cycle one can ensure that all learning styles have been addressed, in that all questions have been addressed. The questions include the following: "Why are we learning this?" "What are the key points of this issue?" "How do I use this knowledge?" and "What are the implications of this information in other contexts?" Figure 2 shows sample activities and role of faculty for Kolb's four different learning styles [38].

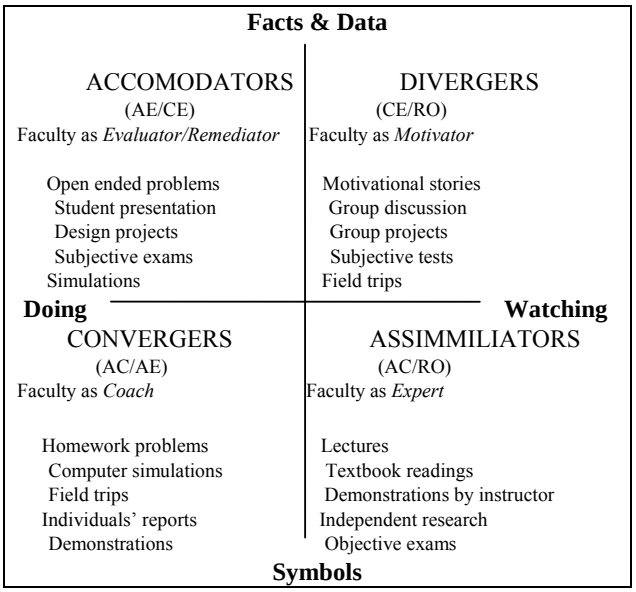

Fig. 2 Sample Activities and Role of Faculty for Each Kolb Learning Style

Although students majoring in a given discipline are more likely to have particular learning style, studies have shown that when learning different subjects, students alter their preferred learning styles [6]. This is to say that learning styles are subject area sensitive. Thus, we should notice that the Turkish ICT teacher education curriculum, like the other subjects' teacher education curricula, has three different groups of courses; (a) *subject-matter* and *pedagogical content knowledge* courses (26 courses including ICT and computer-related courses such as ICT in education, computer hardware, and programming language), (b) *pedagogy* courses (12 courses including teacher education courses such as educational psychology, teaching methods, and classroom management), and (c) *culture* courses (11 courses including out-of-subject-matter courses such as foreign language, the history of science, and scientific research methods). Therefore, prediction of academic achievement of student ICT

teachers with different learning styles for above-mentioned three different course groups are the issues needing further exploration.

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