The role of epistemological beliefs, motivational constructs and Information processing strategies in regulation of learning

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Abstract

The purpose of the present research is to investigate the structural model of epistemological beliefs in regulation of learning (self-regulated learning and external regulation) with regards to the mediatory role of motivational constructs and Information processing strategies. The data were obtained from Tehran University students (290 female and 190 male). They were selected based on a multi-stage stratified sampling. Our Questionnaires in this research consisted of 6 subscales (Inventories of epistemological beliefs, study interest, academic self-efficacy, test anxiety, approaches to learning and regulation of learning). Structural equations model has been used for data analysis. The results confirmed the significant direct effects of epistemological beliefs on our motivational structures (academic self-efficacy, study interest and test anxiety) and also the similar effects of motivational constructs (with the exception of study interest) on Information processing strategies (deep, surface and strategic) and Information processing strategies on regulation of learning. The above mentioned strategies and motivational constructs (academic self-efficacy and test anxiety) had significant mediating effects on the relationship between epistemological beliefs and regulation of learning.

Keywords: epistemological beliefs, self-regulated learning, external regulation, Information processing strategies, academic self-efficacy

1. Introduction

By reviewing the background and the recent models of self regulated learning, we come to this conclusion that assessment and cognition of self regulation, on one hand needs the recognition of cognitive strategies and on the other, the usage of strategies needs sufficient and suitable motivation. Also there is a case in concepts related to epistemological beliefs that such beliefs could be like implicit theories that play a fundamental role in the creation of goals in learning and the selection of self regulation strategies (Braten [7], Neber and Schommer, [17], Hofer, Pintrich [12], Schommer[32], Pintrich [23]). Such a kind of relationship that the new theories try to present integrated and multi-dimensional models about the inter-relationship between cognitive and motivational components of self regulation learning and epistemological beliefs is supposed as certain. The advantage of such multi layer integrated models in experimental studies is confirmed as well (for example, Vermunt, [36], Entwistle, [9] and [10], Schommer, [33]). The conceptual framework for this model is composed of the synthesise of the

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previous works. First we review previous works and inter-relationships between these constructs are discussed and then we present the causal model that guided our research all along. Very little research has empirically examined how epistemological beliefs could influence the other systems such self-regulated learning, cognitive strategies and motivation simultaneously.

1. Conceptual framework

1.1. regulation of learning(self-regulated learning and external regulation)

The main framework for self regulation is on the basis of how students regulate their studies from the cognitive, motivational; the meta-cognitive and behavioural view points (Zimmerman & Martinz-pons, [42]). In Bokaerts’s model [5], there is an equal emphasis on the cognitive and motivational learning factors. In such a model, the information processing methods are among the most important constituents. Baumert [2] recognizes two components for self regulation as cognitive regulation, meta-cognition and motivational regulation. On other hand, Vermunt [38], [37] considers the learning styles as a comprehensive concept consisting of cognitive process strategies, affective strategies, regulation of learning strategies, mental models of learning and learning orientations. According to Vermunt’s model, each of the cognitive processing strategies is related to some particular regulation methods. The cognitive and regulation strategies are related to the students’ conceptions about learning and learning orientations. Conceptions about learning (mental models) refer to a set of conceptions and personal beliefs about quality and nature of learning. Learning orientation would make a reference to all motivation domains like goals, motivations, expectations, interests and anxieties in learning (Vermetten and Vermunt, [38] and [39]). Rosendal & Bokaerts [27] and Entwistle and Peterson [9] found in their studies that those who have a more relative view point to knowledge would gain higher marks in conceptual style. (That means; deep processing, self regulation, making of knowledge and conceptions about learning and being interested in learning). While for the people with an extremist view point concerned with knowledge, there is a higher probability that they have some styles in the sideline reproduction in their learning. (Namely; surface processing, external regulation, knowledge acceptance and formal orientation). In study of self regulatory learning process, paying notice to information processing methods is considered as a very important cognitive factor. In fact, without consideration of information processing, distinction between self regulatory learning and external regulation is impossible (Baumert, [2]). Both the methods of information processing (deep and surface) are forms of regulation from regulation view point. The relations between the information processing and the regulation methods are confirmed experimentally in (Pintrich, [21], Vermunt, [38]) studies. As it is stated by Rosendale and Bokaerts [27], the preference for surface processing is related to a need for external regulations (by teacher and peers). The preference for deep processing is related to self regulation learning. Lancaster’s (1987) study introduced additional category namely strategic or achieving approach. The intention in this approach as well is to act on the basis of assessment criteria (Entwistle, [9]). According to Vermunt’s model [37] and on the basis of consideration to the context for achieving in this approach, there is a use of both methods in the external and internal regulation. But studies indicate that when the learners are aware of suitable methods, they necessarily do not use these methods. (Alert, [1]).

1.2. Motivational constructs and Information processing strategies

Numerous researchers have emphasized on some learning strategies as the mediation of motivation effects on learning outcomes (Pintrich and De Groot, [24], Pokay and Blumenfeld,[25]). A motivation theory that is suitable for merging numerous models defining achievement behaviour is the expectation- value model (Pintrich and Schunk [35]). In this model, the motivation consists of three components. The first component is the ‘expectations’ which is related to the students’ expectation about the ability to perform a task (McKeachine et al, [16]). Among all, there is a kind of self- efficacy. The researches done along two decades clearly prove that self efficacy is a predicting learning and motivation variables. When we use it as a mediating variable, it is proved that it can improve the learning strategies (Specially the self- regulation learning). (Berry, [3], Schunk, [35], Zimmerman, [41]). The second component is the factor of “values” which make a reference to the student’s goals and beliefs about the importance and interest of the task. (Paulsen and Feldman [19]). Among the important items of this equal factor is the interest to tasks and the fields of study. The scholars (Schefele, [31], Schefele, and Krapp, [32]) indicate that the interest positively effects on the deep information processing. The third motivation component is the ‘affects’ that refers to
the emotional responses of the student to the task (Paulsen and Feldman, [18]). One important item of this component is test anxiety. Experimental indications show that the students with a high degree of anxiety would like to process the information superficially.

1.3. Epistemological beliefs, motivational constructs and Information processing strategies

Previous studies proposed several different methods for the creation of motivation in learning. Among the methods is a remark to epistemological beliefs. According to Paulsen and Feldman’s studies [19], the university professors can improve the students’ motivation for learning by giving them assistance in order to improve and grow up their beliefs to change their naive primary beliefs to sophisticated one. Other researches (Hofer & Pintrich, [12], Rozendal, [28], Neber & Schommer [19], quoted by Braten, [7]) has come to some similar conclusions. In their studies, they found out that students with more sophisticated epistemological beliefs have internal motivation, self-efficacy, interest, self regulated learning, and goal orientation in order to reach to high degree of academic achievements. The relations between these beliefs and the motivation for learning might be an indication of a casual relationship among themselves particularly in university studies. In other worlds, the expectation of the existence of casual relationships chain exists among them (Paulsen and Feldman, [20]). So the student’s beliefs about knowledge and learning may impact on the strategic and motivational components of self regulated learning (Braten, [7]). Hofer & Pintrich [12] have also emphasized to examine the possible relationship between these beliefs in motivation and strategies within theoretical frameworks of self regulation. Schommer [33] presented an embedded systematic model of epistemology as a system of this model which has inter-relationship with systems of cognition, self-regulated learning and performance. On other side, we find similar factors in the present self regulatory learning models, among which is the Vermunt's [37] and Entwistle's model [9]; with an embedded systematic model [32]. The experimental researches (Entwistle [9], Vermun [37]) confirm the idea that there exists a strong relationship between the use of simplistic knowledge and the usage of memory, surface processing and external regulation (Baumert et al. [2]). According to Schommer’s quotation, the fact is that some series of beliefs which are assessed by different research view points, would not necessarily lead to unfavourable situations. But on the contrary, there is only a need for a merging model in which there could exist different results and that could be recognized in a common relationship to each other. So the purpose of the present study is to examine the effects of epistemological beliefs in regulation of learning (self and external regulations) with the consideration of the mediatory role of motivation structures and information processing.

1.4. The Conceptual model

The hypothetical model of this study is a merge of theoretical models (Bokaerts, [5], Baumert [2], Vermut [37], Schommer, [33], Entwistle, [9]) that covers their intersection. Therefore considering the present indications and the numerous advices of the scholars about the study of probable relations between epistemological beliefs, selection of strategies and effective motivational constructs are in the form of self regulatory learning models (Schommer, [33], Entwistle, [9]). Hofer and Pintrich [12], as well as considering numerous studies and the measures the effects on all mentioned factors simultaneously. In such a research, we studied the causal effects and the role of each variable in the form of a conceptual model as it is presented. According to the theoretical models mentioned and the findings in studies, our first hypothesis is that epistemological beliefs have casual effect on motivational structures (self efficacy, interest and test anxiety). Also based on the relations mentioned in previous studies, the second hypothesis is that the motivational structures have direct casual effect on information processing strategies (deep, strategic and surface). Definitely, the effects of motivational constructs mentioned, considering the kind of motivational component, are different on processing strategies. Therefore our other hypothesis is about the mediating role of motivational constructs between the epistemological beliefs and the strategies of information processing. That means the epistemological beliefs have indirect effect on processing strategies through direct effect on motivational constructs. On the other hand, the strategies of information processing have direct effect on regulation of learning (self- regulation and external regulation). On this basis the theoretical models and previous findings show that the effect would be different considering the kind of information processing. So our next two assumptions are about the mediating role of motivational constructs and the information processing strategies between epistemological beliefs and self regulatory learning vis-à-vis the external regulation on the other hand. That means the epistemological beliefs have indirect casual effect on strategies of information processing (self regulatory and external regulation).
through direct effect on motivational constructs. So, the method used in the present study follow the correlation designs of the kind of structural equations.

![Conceptual Model](image)

**Fig. 1. (Conceptual Model)**

### 2. Method

#### 2.1. Sample

The Tehran University college students in B.S. field of Statistics composed a research consisting 17223 students who used the multi-stage stratified accidental sampling method and by selection of 480 persons (290 girls and 190 boys) they divided them to 5 academic groups. According to the number of students and their value in society, the number in each classification was determined.

#### 2.2. Instruments

The students expressed their views in 5-point Liker scales (1=strongly disagree, 5= strongly agree) with the exception of 4-point Liker scale of study interest. The value of the structure of such questionnaire was examined and confirmed by factor analysis (confirmatory and exploratory). The estimation of coefficients was done by the maximum likelihood. The assessments of fitting Indexes in each questionnaire were according which were relatively good among the confirmed models.

Epistemological beliefs: the short and revised form of Schommer's Questionnaire (SEQ) was used (15 items). Schommer [34] has taken as a hypothesis that the epistemological beliefs are in a system of composing the beliefs that are more or less independent about the nature of knowledge and learning. The usage of the shorter forms questionnaires considering the presence of numerous variables in this research could be effective. Such a scale consists of four dimensions. Each of the dimensions, consists of a line on each side of which there are some naive beliefs (belief on certain or absolute knowledge, simple and discrete knowledge and being separate from the fact and the belief on quick learning and fixed ability to control it). At the end away from other beliefs, there is the belief on the existence of relative knowledge, the gradual and improvable learning, and a belief on learning through experience). The dimensions are: certainty of knowledge, the speed of learning, construction, simplicity of knowledge and control of learning. The reliability coefficients (Cranach's α) of 4-subscale for the mentioned factors were respectively 0.62, .50, 0.30and 0.45. Estimates gave acceptable goodness of-fit indices; RMESA= 0.05, GFI= 0.91, CFI= 0.79, $\frac{\chi^2}{df}=2.6$.

Academic Self Efficacy Questionnaire (ASEM): we used the Mccllory, &Bunting’s scale [17] which consists of 10 items. In the present study, we came to ($\alpha = 0.72$). The results of the confirmed analysis led to the omission one item from scale. The fitting indexes estimates were equal $\frac{\chi^2}{df}=3.2$, RMESA= 0.068, GFI= 0.91, CFI= 0.92.

Information processing strategies: different levels of information processing are reflected in three levels, each of which respectively reflects the performance and understanding from learning (Diseth and Martinsen, [8]). In the present study, the sub-scales of information processing strategies (the cognitive strategies of learning) in the SPQ Questionnaire (Biggs; 1987) were used which consisted of 21 items and three surface, deep and strategic
information processing strategies. The coefficients of Cranach's α were respectively as follows: 0.64, 0.77, and 0.79. The fitting indexes were; $\chi^2/df = 2.3$, RMSEA = 0.05, GFI = 0.93, CFI = 0.90.

Regulation of learning: We used the Vermunt’s ILS Questionnaire (Inventory of Learning Styles, [37]). The sub-scale learning regulation in ILS composed of 25 items that assess three types of regulations (internal, external and without any regulation). We did not use the sub-scale of without regulation. The Cranach's α in the present study is (α=0.80). The fitting indexes were; $\chi^2/df = 2.1$, RMSEA = 0.05, GFI = 0.88, CFI = 0.90.

Study Interest: such a concept is defined as a specification that indicates a set of feeling attributions (enjoyment, boring and …) and value attributions (meaningfulness, usefulness and…) about studying a subject or field of study. We used Schefele’s et al (SIQ) scale (1993) which consists of 18 items. The results of primary confirmatory factor analysis with one factor did not lead to some good fitting indexes. So an exploratory factor analysis performed with principal component method. The Oblimin rotation led to three factorial structures. The Cranach's α for the factors were respectively; 0.79, 0.84, 0. 65. The fitting indexes were; $\chi^2/df = 2.5$, RMSEA = 0.05, GFI = 0.83, CFI = 0.89.

Test anxiety: we used the subscale of test anxiety in Pintrichs’ MSLQ scale (Motivated Strategies for Learning Questionnaire, 1991). The sub-scale consisted of 5 items. The coefficient of Cranach's α =0.88. The fitting indexes were; $\chi^2/df = 6$, RMSEA = 0.12, GFI = 0.95, CFI = 0.97.

2.3. The Statistical Method

In order to estimate the direct and indirect effects (the casual relations) of the variable, we use structural equations model. In models of structural equations, the structure of covariance under the relationship between the variables are according the hypothesis in the form of a path diagram are marked, the parameters are considered in mind and then the parameters related to the model are analyzed thoroughly. In order to have a descriptive analysis, confirmatory factor analysis and the model of structural equations from the SPSS and LISREL 8.54 software, are used. In the model we have three indicators for each latent variable (except the epistemological beliefs that have four indicators for every dimension) is considered. The covariance matrix between the variables in structural equations models were used as a given data which are the basis of analysis.

Table 1. Covariance matrix of variables, means and standard deviations.

<table>
<thead>
<tr>
<th>An example of a column heading</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-self-regulation</td>
<td>0/47</td>
<td></td>
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<tr>
<td>2-external regulation</td>
<td>0/06</td>
<td>0/33</td>
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<td></td>
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</tr>
<tr>
<td>3-surface processing</td>
<td>-0/01</td>
<td>0/33</td>
<td>1/04</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-deep processing</td>
<td>0/31</td>
<td>0/02</td>
<td>-0/04</td>
<td>0/55</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-strategic processing</td>
<td>0/30</td>
<td>0/17</td>
<td>0/03</td>
<td>0/13</td>
<td>0/76</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-interest</td>
<td>0/11</td>
<td>0/01</td>
<td>-0/03</td>
<td>0/15</td>
<td>0/10</td>
<td>0/64</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-anxiety</td>
<td>0/14</td>
<td>0/02</td>
<td>-0/05</td>
<td>0/18</td>
<td>0/17</td>
<td>0/14</td>
<td>0/24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8-self-efficacy</td>
<td>-0/02</td>
<td>0/12</td>
<td>0/32</td>
<td>-0/11</td>
<td>0/10</td>
<td>-0/08</td>
<td>-0/14</td>
<td>0/96</td>
<td></td>
</tr>
<tr>
<td>9-epistemological beliefsa</td>
<td>-0/08</td>
<td>-0/01</td>
<td>0/02</td>
<td>-0/10</td>
<td>-0/10</td>
<td>-0/08</td>
<td>-0/13</td>
<td>0/07</td>
<td>0/07</td>
</tr>
<tr>
<td>10- mean</td>
<td>28/30</td>
<td>28/49</td>
<td>18/95</td>
<td>21/97</td>
<td>18/65</td>
<td>22/26</td>
<td>25</td>
<td>10/10</td>
<td>-</td>
</tr>
<tr>
<td>11-standard deviation</td>
<td>7/40</td>
<td>6047</td>
<td>4/41</td>
<td>5/02</td>
<td>5/20</td>
<td>6/97</td>
<td>5/44</td>
<td>4/97</td>
<td>-</td>
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</table>

* In this study we used of naïve epistemological beliefs accordingly Schommer's Questionnaire.
Fig. 2. (structural equation model of regulation of learning, according to exogenous and mediating variables).
3. Results

The result of examining the conceptual model indicates as appropriate goodness of fit indices. The $x^2=544.07$, df =334, the ratio $x^2/\text{df} = 1.6$ smaller than 2. the Root mean square residuals (RMSEA) was 0.37 which is less than %5, and expected Cross-Validation Index (ECVI) of the model was less than the (ECVI) for the saturated model ($1.47 < 1.74$). The indices for Comparative fit Indexes were (CFI) =0.92 and non-normal fit Indexes (NNFI) =0.92, that according to Bentler & Hu [13] advice should stand higher than (%90). However the indices for goodness of fit (GFI) =0.88. We can conclude that the model fits well and represents close approximation in the population. Also the coefficients of direct effect in the model indicate that epistemological beliefs have the most direct effect on academic self efficacy (definitely the coefficient has a bias effect), the self efficacy has a similar effect (0.48) on deep and strategic processing and similar variance defined on both of the approaches. Also on the basis of expectation, the test anxiety has a direct significant effect on the surface and strategic processing. Certainly the anxiety has direct effect on surface processing (0.32) more than its effect on deep processing which is (0.25). Also deep and surface processing has significant direct effect respectively on self regulation (0.53) and external regulation (0.55). The strategic processing also has a significant direct effect on both the methods of regulation (self (0.39) and external regulation (0.31)). Among the mentioned variables, only the interest does not have significant direct effect on the deep processing. Epistemological beliefs have the most indirect effect on strategic and deep processing (respectively 0.55 and 0.52.).Also self efficacy in studies has a stronger indirect effect (0.44) on self regulation rather than the external regulation (0.15). On the contrary, the test anxiety has a more variance indirect effect (0.25) on external regulation rather than the self regulation (0.10). Totally the present variables in the model define approximately %52 of variance in self regulation and %42 of variance in external regulations. It is remarkable that the Schommer's systematic model epistemological beliefs [33] and Entwistle [9] are presented as a general view point. In this study, whether to be naive or sophisticated beliefs, what is generally considered in mind is that there is not a relationship between the dimensions separately with each of the other variables.

4. Conclusion

The outcome results show that epistemological beliefs have significant casual effect on each of the motivational constructs (interest, academic self -efficacy and test anxiety). The outcome result is very similar to the previous studies results about this field (Braten [7], Paulsen & Feldman, [19], [20], Hofer and Pintrich[12], Neber and Schommer [18], Kardash and Scholes [14]). Definitely, at the result of the effects, the latent variables about the possibility to investigate about which one is effective and which one does not exist, are assessed thoroughly. But the latent naive epistemological variable has casual significant negative effect on self-efficacy and interest as a whole. According to Kardash's idea [14], those who believe less on certainty of knowledge, show less effort in to emphasize on their primary beliefs. They are rather more interested to engage the challenging tasks. Also, the findings of the present study indicate that naive epistemological beliefs have significant casual positive effect on test anxiety that show they are inflicted by negative affects more in the examinations and education opportunities. Also the academic self efficacy has a significant casual positive effect on the use of strategies in deep and strategic processing. The results are along the studies emphasize the importance of learning strategies as the mediating motivational effect on the outcome learning (for example: Pintrich and De Groot [24], Pokay and Blumenfeld [25], Paulsen and Feldman, [19], Zimmerman and Martinez- Pons, [42]). Another result indicated that interest does not have significant effect on deep processing, when it comes with self- efficacy, all were studied. This result should be considered by paying attention to the overlap effect of self-efficacy variable. self- efficacy have a significant (0.45) relation with the interest and on the other side the relationship between self- efficacy and deep processing is more than the relationship between the interest with deep processing. Such a thing would cause the interest not to be able to define a high variance from the deep processing strategy. Among the other results, the positive effect of test anxiety on both surface and strategic approaches is significant. The result proves the Sarason’s axiom of dual test anxiety functionality [29], Sarason&Mandler [28], Richmond [26]. The significant effect of test anxiety on strategic processing indicates the importance of evaluation in producing anxiety. Also, the results show that the deep processing on self regulation, surface processing on external regulation, strategic processing on external regulation and self regulation have significant positive casual effects. The results are similar and homogeneous with numerous studies that work on the relationship between the information processing strategies and regulation of learning (Entwistle, [10], Pintrich [21], Rosendal and Bokaerts,[27],Braten [7], Vermetten and Vermunt[40] , [39] and
Bieshuizen et al [4], Zimerman and Martinz Pons[42]). The findings of the present study confirm the mediating role of self-efficacy and test anxiety study. Testing the mediating role of the present variables in the conceptual model indicate that the epistemological beliefs have indirect causal effect on deep processing with a direct mediatory effect on self-efficacy, and self regulatory learning. The mediatory role of learning strategies is also assessed in some studies (Tait and Entwistle, [36], Vermunt, [37]). The mediating role of study self-efficacy among the epistemological beliefs, information processing strategies and self regulatory learning are similar to the results of the Berry, [3] and Schunk’s study, [35]). As a whole, the results of the study show that the motivation constructs (study self- efficacy and test anxiety) and the information processing strategies (deep, surface and strategic) play a mediatory role among the epistemological beliefs and learning regulation. The casual and fundamental role of the epistemological beliefs is clear in definition of variance of motivational constructs, the information processing strategies and the learning regulation. Also the results are compatible with the Pintrich's hypothesis [21] about the constructive nature of knowledge and learning, the mediatory role of motivational and cognitive processes in self regulatory learning. So, according to the above mentioned findings, and the conceptual model, the professors and masters could notice the effective factors in change and the progress of epistemological belief, through the creation of thinking challenges in learning situation and the epistemological beliefs subject content of the student that could go under question. The masters could help the students to take their difficulties in learning as challenges that create particular opportunities for the improvement of their capabilities in learning. They should pay more attention to the use of different supervisory methods of learning. They should present the problems without the structure in the subject matter and promote to look from different angles to the difficulties and indications. They should help the students to relate what they learn in the classroom to different opportunities. So that through the method they could reach to a real understanding of how to have a judgment which could change in different conditions and it is re-structure again. Also the professors should make positive effects in self regulation learning process with improving the self- efficacy beliefs, the reformation of examination and the study evaluation system by strengthening the positive affections in order to decrease and control the level of test anxiety and make situational interest.

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