Evolutionary Trend of Logical Thinking in Higher Education: Curricula and Development of Graduate Students’ Logical Thinking

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Abstract
The current study aimed to investigate the evolutionary trend of graduate students’ logical thinking as to university curricula. This survey was a comparative study. 206 students were selected by applying stratified random sampling method as to their academic levels (161 MD versus 45 PhD students). They completed “logical thinking questionnaire”. Findings showed a significant difference between MD and PhD students’ logical thinking scales in favor of PhD students ($F_{(1, 202)}= 8.79$, $P<.01$), and between female and male students in favor of female ones ($F_{(1, 202)}= 19.64$, $P<.001$). The size effect by eta squared showed that there was no significant relationship between students’ gender and educational levels as to their logical thinking ($F_{(1, 202)} =.12$, $P=.725$). These findings emphasized the important role of curricula in developing logical thinking and recalls for need to design appropriate curricula in relation to logical thinking skills in all academic levels, especially graduate ones.

Keywords: curriculum, higher education, logical thinking, curriculum elements

1. Introduction
Education system has undoubtedly a basic role in society development. Its objective is to train graduates who engage in scientific activities by applying various thinking manners. One of the main responsibilities of each education system is to train analytical and criticizing minds. This can be achieved by incorporating these notions into curricula and courses (Parirokh and Fattahi, 2005). As Sha’bani (1999) says, some researches showed that developing thinking skills has been regarded as a main priority of educational organizations’ plans. Logical thinking is of the most complex and excellent manifestations of human thinking and various perspectives on the notion have been emerged (Wang, Wang, Patel and Patel, 2006). Kant (2008) argues that education systems must focus on teaching thinking rather than teaching thoughts as an educational end. It is obvious that understanding the depth of thoughts and perceptions requires logical thinking as a dimension of thinking process (Epstein, Pacini, Heier and Denes, 1996). Nowadays, when talking about logical thinking, the definition by Aristotle and his logics come into consideration as the common definition (Husu, Toom and
Patrikainen, 2008). Logical thinking, however, does not merely mean thinking based on the frameworks and regulations Aristotle suggested. This is not limited to Aristotle's logics and incorporates other logical frameworks such as Dewey's problem-solving method (Kant, 2008) and Reflective thinking has the strongest influence on lifelong learning (SteurT Jansen & Hofman, 2012). Logical thinking as a key element of graduations (Van Rossum and Hamer, 2010) and students should recognize that knowledge is uncertain and that they must integrate information from different angles in order to reach a conclusion (King & Kitchener, 2004). Since logical thinking does not necessarily result in problem solving, it tends to improve the perception of the problem at hand and increase individuals' tolerance of ambiguity (Tanner, 1996). Sterenberg (1996, cf: Hosseini, 2009: 26-27) points out that logical thinking involves three components including performance, knowledge acquisition and meta-component. Cooper (1980) argues that logical thinking is the ability to infer a certain event and affair by using limited information. Wang and Chiew (2010) describe in details the main features of logical thinking as follows:

-Action expansion: trying to explore and expand various aspects of a problem or issue in order to select the best solution to follow.
-Action path and direction: following a certain path and direction which an individual knows what h/she traces and how h/she can achieve the end.
-Action sequence: this implies the dependence of a stage of logical thinking to another and their sequence.
-The quality of encountering mistakes and irrelevant problems: By trying to avoid any mistakes and involving in relevant issues, one selects some ways that ensure some ends. Logical thinking is judging and evaluating aspect of thought that is limited by existing realities.

Huff (1999) points out that the act of writing is an integral part of logical thinking and creativity, and it is therefore a smart move to make writing a regular habit as a postgraduate student. Daly (1998) conceives logical thinking as a combination of abstract thinking and critical thinking, and a process that involves detailed evaluation and logical conclusion related to relevant information which in turn results in logical judgment. It appears that exposure to education improves thinking skills. As curricula are of main resources of learning, they can play a main role in learners' familiarity with/educating/improving logical thinking. Nowadays, due to an increase in the complexity of life's problems and social organizations and institutes, some special education is needed to improve an individual's capacity to adopt this complex environment and enhance his/her productivity as to the society. While logical thinking is affected by different environments such as home, school, university, media, and curricula and so on, curricula obviously provide an appropriate context for it. University curricula are of main elements of creating logical thinking. Then, they have to be able to improve students' higher order thinking skills during their academic years. There are some evidences that reveal that curricula can improve different dimensions of thinking (Karami, Pakmehr and A'ghili, 2011) or cause some obstacles to them (Amin-Khandaghi and Pakmehr, 2011). In their book entitled Developing Skills for Business Leadership, Watson and Reissner (2010) regarded logical thinking as a skill needed for students' reading and its empirical aspects. Furthermore, the students need to be receptive toward developing a reflective attitude (Kember and et al, 2000).

Based on the study conducted by Amiri (2011) and Emir (2009), university students' logical thinking skills have not unexpectedly changed during their academic years. These findings show the potential important role of curriculam as a component of education systems in improving learners' thinking abilities. Curricula should aim to encourage students in enquiry, analysis, innovation, judgment, and critical and logical thinking (Chen, Kinshuk, & Liu, 2011). Ornstein and Hunkins (2009) argue that the main assumption all thinking-based curricula have is that there are some common processes and/or skills regardless of their subjects or objectives. Many researchers believe that student have some problems in dealing with thinking skills, especially those of logical thinking. And Hvlfysh et al (2008) note that logical thinking involves active, accurate and continuous enquiry about each view or knowledge claim as to the reasons confirming them and concluding from them; but logical thinking can not be improved in curricula due to serious ignorance of the relations between facts and main problems and issues and contradictory realities about them, especially in human side.
Regardless of different definitions of curriculum discipline, the nature of this discipline is formed in such a way that it is not possible to expect some certain and accurate responses of studying different dimensions and topics involved in curriculum as a whole. The main aim of the discipline is potentially to enhance our understanding of the paradigm complexities and shifts occur in the domain. Considering the necessity for unity and integration amongst various components and domains of educational field, as well as that of preventing possible disconnection from practice area, it is needed to distinguish between two concepts in order to determine the accurate subject inclusion and limitations of curriculum and its relation to practice (teaching-learning) area. These concepts are curriculum as a written document, and curriculum as a professional, scientific and study field. Curriculum as a written document includes content, aims and plan. As a content, curriculum involves certain curricular content, subject and matter listing. Such a view has been dominated in the works of perennalist and essentialist theoreticians. Despite its understandability, their definition is completely limited. Curriculum includes the subjects considered for teaching learners. As an experience, curriculum is highlighted in progressivism viewpoint and ranges from students’ experiences to their school and life. As a learning plan or map, it is considered as “a learning plan” (Taba, 1962) and ranges from planning for a course to planning for all learning activities involved in home and school works. Curriculum as a content, experience and plan is a product of curriculum design and has had an evolutionary trend from curriculum concept during the past one hundred years. Curriculum as a professional, scientific and study field does not merely conceive curriculum design as a technique of preparing curricula for school and educational centers, but emphasizes on the understanding, perception and study of complex curricular dimensions. Although curriculum design should be regarded as an important activity of curriculum discipline, its concern is not limited to only dealing with usual and common issues (Fathi-Vajarghah, 2007) and interested in studying the issues relating to school-related matters and events occurring within these affairs as well as its relation to environment. The main concern is to understanding curriculum as a phenomenon.

Curriculum elements include all actions and experiences prepared as curricular matters. Ornstein and Hunkins (2009) point out that curriculum objective must set forth rationale dimensions and concentrate on knowledge understanding, problem solving, skill training, and various levels and manners of thinking. As Marzino (2001) argues the lack of learners’ personal aims in curriculum objective set and/or learners’ unawareness of its end and purpose result in missing the opportunity for understanding the connection between learning objectives and thinking strategies. In addition, curriculum contents in graduate education need to include higher-order thinking such as ability to use evaluation, presenting reasons for expressed arguments, validating the contents learners receive from instructors and curricula (Wan-Sulaiman, Abdul-Rahman and Dzulkifli, 2007). Based on Shahabi (2005), curriculum content should focus on basic reasoning tools and skills and opportunity for improving learners’ thinking skills. Regarding teaching-learning element, it has been argued that developing logical thinking needs teaching methods that help students improve their abilities to think critically. Existed teaching methods, however, take more time to subjects with discrete and certain responses rather than developing thinking skills and learners are only asked to list and memorize subject matters rather than analyzing, evaluating, interpreting and relating them (Santrick, 2008). Generally speaking, not only teaching methods, but also curriculum in general should concentrate on thinking skills in higher education (Worrell and Profetto, 2007). The studies by Doyle (1983) in U.S. education system showed that what is evaluated formally is the only driving force of curriculum content which is represented in class environment. As a result, learners focus heavily on exercises that fulfill the needs of formal exams and quizzes. We, however, want students to take thinking skills into account. Then, we need to give them some responsibilities in performing the different processes, skills and details involved in curriculum. Using class-based practical exercises and qualitative evaluations including among others observation, interaction, documentation and interpretation are of evaluating methods for improving thinking skills (Marzino, 2001).

In summary, the role of curriculum in developing logical thinking is obvious. It is expected that learners’ logical thinking ability increasingly improves during academic education years, especially in higher educational levels. As the study of developing logical thinking is worth noting in all educational levels, its importance and necessity is more in higher education, especially in graduate levels. The current study aimed to investigate the evolutionary trend of graduate students' logical thinking as to their gender and educational level.
2. Method

2.1. Participants

The study population included all graduate students majoring in Ferdowsi University of Mashhad, Iran during the academic year of 2010-2011. Out of them, 206 students were selected by applying stratified random sampling method as to their academic levels (MD versus PhD). 161 (78.2%) and 45 (21.8%) students were MD and PhD students, respectively and 133 (64.1%) and 73 (35.9%) were female and male graduate students, respectively.

2.2. Instruments

The participants completed "logical thinking questionnaire" (Kazemi, 2000). The questionnaire consists of 6 open-ended two-sectioned questions with responding time of 4 minutes for each question. The first section of each question includes one's short answer. The second section includes the reason(s) in supporting him/her answer provided in the first section and are used for evaluating him/her logical thinking. The questionnaire has three components: a) dynamics or the total count of ideas: one point is dedicated to each idea; b) flexibility or the count of categories each idea falls into: one point is dedicated to each new category, and c) validity or the count of valid ideas: one point is dedicated to a new idea. Kazemi (2000) reported that the formal validity of the questionnaire as confirmed by three educational specialists. The reliability by factor analysis and Cronbach's alpha coefficient amounted to a= .71. Scaling by 3 correctors resulted in correlations of .73, .68 and .65. In another study, (Kazemi, 2010) reported Cronbach's alpha coefficient for reliability amounted to a=.72. This amounted to a=.70 in our study. The participants completed this questionnaire. Collected data was analyzed by descriptive and analytical statistic methods in SPSS 19 software.

3. Results

Table 1 shows the demographic information of the participating students (n= 206). 161 (78.2%) and 45 (21.8%) students were MD and PhD students, respectively and 133 (64.1%) and 73 (35.9%) were female and male graduate students, respectively.

<table>
<thead>
<tr>
<th>variable</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational level</td>
<td>MD</td>
<td>161</td>
</tr>
<tr>
<td></td>
<td>PhD</td>
<td>45</td>
</tr>
<tr>
<td>Gender</td>
<td>Female</td>
<td>133</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>73</td>
</tr>
<tr>
<td>Total</td>
<td>---</td>
<td>206</td>
</tr>
</tbody>
</table>

Table 2 shows the mean and standard deviation of students' logical thinking scales as to their gender and educational level. The mean rate of PhD student in logical thinking was higher than that of MD students. The mean rate of female students' logical thinking scales in both educational levels was higher that of male students.

<table>
<thead>
<tr>
<th>Group</th>
<th>Female (n=196)</th>
<th>Male (n=161)</th>
<th>Total (N=206)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MD</td>
<td>PhD</td>
<td>MD</td>
</tr>
<tr>
<td>Indicators1</td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Logical thinking</td>
<td>25.05</td>
<td>8.14</td>
<td>30.13</td>
</tr>
</tbody>
</table>
As shown in Table 3, one-way ANOVA for comparing students' logical thinking scales as to their gender and educational levels showed a significant difference between MD and PhD students in favor of PhD students ($F(1, 202) = 8.79, P<.01$), and between female and male students in favor of female ones ($F(1, 202) = 19.64, P<.001$). The effect size by eta squared ($\eta^2$) showed that there was no significant relationship between students' gender and educational levels as to their logical thinking ($F(1, 202) = .12, P=.725$).

<table>
<thead>
<tr>
<th>variable</th>
<th>SS</th>
<th>$df_1$</th>
<th>$df_2$</th>
<th>MS</th>
<th>$F$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational level</td>
<td>665.51</td>
<td>1</td>
<td>202</td>
<td>665.51</td>
<td>8.79</td>
<td>0.003**</td>
</tr>
<tr>
<td>Gender</td>
<td>1486.57</td>
<td>1</td>
<td>202</td>
<td>1486.57</td>
<td>19.07</td>
<td>0.000***</td>
</tr>
<tr>
<td>Interaction of education level and gender</td>
<td>9.36</td>
<td>1</td>
<td>202</td>
<td>9.36</td>
<td>0.12</td>
<td>0.725</td>
</tr>
</tbody>
</table>

*P< .001 **
P< .01**

4. Conclusion and discussion

This study aimed to investigate the evolutionary trend of logical thinking among the graduate students of Ferdowsi University of Mashhad, Iran. There were significant difference in participants' logical thinking as to their gender from one hand and their education level from the other hand.

PhD students had higher mean rate in logical thinking than MD students. It can be argued that university curricula as only one affecting factor have resulted in the enhancement of students' logical thinking. It is expected that students' logical thinking improves increasingly as they engage continuously in education and research contexts as well as life's experiences during their academic years.

As female students had higher mean rate in logical thinking than male ones, it can be said that logical thinking is gender-dependence and female students have been able to improve their mental capacities and logical thinking skills. This finding is in accord with that of Gilstrap and Dupree (2008) and Kazemi and Nik-manesh (2010). These findings recall the need to study neurological principles of logical thinking relating to gender in order to develop females' logical thinking and improve males' logical thinking. Other external factors such as cultural views and gender perspectives may play a role. The clarification of the role of these and other possible factors need further research in various contexts. The size effect by eta squared showed that gender and educational level had not any significant relationship as to their interacting effect on logical thinking. The interaction of gender with educational level had not affected logical thinking. Conducting other mix method studies is needed to establish the finding.

In conclusion, the results of this study showed the positive effect of university curricula on graduate students' logical thinking. This result is rationale, because we expect higher education curricula to enhance the ability of students majoring in higher educational levels. Considering the capacities of various academic professional fields and using the curriculum field can provide the excellent opportunity to develop learners' logical thinking. Considering the importance of logical thinking in various educational levels and period, it is suggested that other affecting and relating factors are identified by conducting some appropriate quantitative and qualitative studies. Studying the role of family, cultural context, socio-economic conditions and teaching-learning approaches in learners' logical thinking are necessary to better explanation of the phenomenon. This identification helps educators to expand logical thinking skills in higher education curricula.

References


