T. Hirashima et al. (Eds.) (2011). Proceedings of the 19th International Conference on Computers in Education. Chiang Mai, Thailand: Asia-Pacific Society for Computers in Education

Metacognitive Student Model

Alejandro PEÑA-AYALA[a*], Rafael DOMÍNGUEZ-DE LEÓN[b] & Riichiro MIZOGUCHI[c]
[a]*WOLNM, ESIME-Z & CIC IPN, ISIR, Osaka University, México-Japan*
[b] *ESIME-Z, IPN, México*
[c]*ISIR, Osaka University, Japan*
*apenaa@ipn.mx

Abstract: In this paper, we wonder: How aware are learners of their metacognitive skills at studying? In order to respond such a question, we propose a student model to acquire, measure, and depict basic metacognitive skills of learners. Our metacognitive student model describes underlying concepts of knowledge and regulation domains. The first experiment reveals: Groups of college students own a wide gray-level scale of awareness of their metacognitive skills.

Keywords: Metacognition, metacognitive knowledge, regulation, student model

Introduction

According to Flavell,. Metacognition is: "…the monitoring and consequent regulation and orchestration of cognitive transactions in relation to the cognitive objects or data on which they bear, usually in service of some concrete goal or objective" [4]. In words said by Gama: "Metacognitive knowledge consists primarily of knowledge or beliefs about what factors or variables act and interact in what ways to affect the course and outcome of cognitive enterprises" [6]. Metacognitive regulation refers to processes that coordinate cognition [3]. With the aim to model learners' metacognitive skills, we tailor the first version of our metacognitive student model with two key domains: knowledge and regulation. Thus, we account several models, strategies, and tools to set the nature of both components and define how to represent them. Moreover, we design and develop a trial to elicit responses of a group of college students about their beliefs, habits, and likings at learning.
This paper is organized as follows: In section 1, a trial and the statistical results are given. In section 2, the interpretation of results, the conclusions and the future work are set.

1. Experiment

1.1 Settings

We use the Metacognitive Awareness Inventory (MAI) set by Schraw and Dennison [18]. MAI elicits information about learner's beliefs and habits. It is a test of 52 questions (Q) to be answered as true or false (i.e., statistically speaking 1 and 0). Based on the learner's responses, MAI estimates her level of *metacognitive awareness*. Moreover, it is split into *metacognitive knowledge* and *metacognitive regulation* of $Q_{MK} = 17$ and $Q_{MR} = 35$ questions respectively. Both supersets are respectively organized into three and five concepts. Thus,

metacognitive knowledge owns three concepts (e.g., declarative, procedural and conditional knowledge) and metacognitive regulation contains five (e.g., planning, information management strategies, comprehension monitoring, debugging strategies, evaluation).

1.2 Results

The MAI questionnaire was applied to a sample of college students, who pursue a bachelor degree in Information Technologies in Mexico. The size of the sample was 25 (*N*). The volunteers are studying their fifth semester of a program composed by eight semesters.
As the range of true responses scored for a participant is 0 to 52 and all volunteers answered the inventory, the maximum possible number of true values is T =1,300 (i.e., as $N * Q = 25 * 52$). So any question could be positively responded from 0 to 25. Based on these items, a resume of the descriptive statistical analysis is given next. Such a briefing is organized into three layers: 1) Inventory. It corresponds to the level of *metacognitive awareness* concerning to *Q*; 2) Domain. It reveals the level of metacognitive knowledge and metacognitive regulation according to Q_{MK} and $Q_{MR}r$ respectively; 3) Basic concept. It represents the prior stated eight concepts for Q_{DK}, Q_{PK}, Q_{CK}…
As regards the inventory layer, an ascending frequency of affirmative answers given by the sample *N* is set in Table 1, where *id* identifies the volunteer; *fr* is the frequency of affirmative responses; *%* is the percentage frequency (i.e., *fr* / *Q*). It shows: the sample scored 821 truth answers, a 63% of *T*. Based on *Q*, the mean is 32.8 positive answers per subject and the median is 33. The range is 25 from a maximum of 44 minus a minimum of 19, which corresponds to 85% and 37% of *Q*. So there is a 48% of difference between the volunteer with the least metacognitive awareness and the participant with the highest one!
Concerning the *Q* questions, an ascending frequency of true responses is given in Table 2, where *#* is the question's *id* and *fr* is the frequency of positive answers. Obviously, there are 821 true responses, the 63% of *T*. Based on *N*, the mean is 15.8 and the median is 16. The range is 20 from a maximum of 24 and a minimum of 4, which represents the 96% and 16% of *N*. It states: there are some nearly unknown metacognitive practices (e.g., *#4*: "*I periodically review to help me understand important relationships*") and some common habits (e.g., *#45*: "*I learn more when I am interested in the topic*").

id	*Fr*	%	*Id*	*Fr*	%	*Id*	*Fr*	%	*Id*	*Fr*	%	*Id*	*Fr*	%
8	19	37	13	27	52	20	31	60	24	35	67	21	38	73
6	23	44	4	28	54	2	32	62	10	36	69	16	41	79
7	23	44	5	30	58	23	33	63	15	37	71	25	41	79
3	27	52	11	31	60	18	34	65	17	37	71	14	44	85
9	27	52	12	31	60	1	35	67	22	37	71	19	44	85

Table 1. Frequencies of true responses given for each volunteer of the sample

#	*Fr*	#	*Fr*	#	*Fr*	#	*Fr*	#	*Fr*	#	*Fr*	#	*Fr*	#	*Fr*	#	*Fr*
21	4	24	10	50	13	36	15	30	16	32	17	27	18	29	20	25	23
28	6	33	10	34	13	49	15	45	16	40	18	10	18	5	20	3	23
8	7	14	10	48	13	41	15	42	16	39	18	1	19	51	21	52	24
37	9	38	11	19	14	4	15	18	16	13	18	7	19	2	22	46	24
6	9	11	12	22	14	17	15	44	17	23	18	31	20	43	22		
16	9	12	12	20	14	47	16	35	17	26	18	9	20	15	22		

Table 2. Frequencies of true responses given to each question of the MAI questionnaire

2. Interpretation of results and conclusions

The analysis of the metacognitive knowledge domain shows: The sample scored 283 truth answers, the 67% of a maximum of 425 (i.e., $N * Q_{MK}$). Based on Q_{MK}, the mean is 11.32 positive answers per subject and the median is 11. The range is 8 from a maximum of 15 and a minimum of 7 that corresponds to 88% and 41% of Q_{MK}. Thus 47% is the difference between subjects with the highest and the least metacognitive knowledge!
The statistics of true responses for the Q_{MK} questions of metacognitive knowledge show: Based on *N*, the mean is 16.6 and the median is 17. The range is 15 from a maximum of 24 and a minimum of 9 that corresponds to the 96% and 36% of *N*. It reveals: at least the likings are known by a third of the sample (e.g., *#16*: "*I know what the teacher expects me to learn*") and there are some habits well know by nearly all the members of the sample (e.g., *#46*: "*I learn more when I am interested in the topic*").
The results of the metacognitive regulation domain show: The sample scored 538 truth answers, the 61% of a maximum of 875 (i.e., $N * Q_{MR}$). Based on Q_{MR}, the mean is 21.5 positive answers per subject and the median is 21. The range was 20 from a maximum of 30 and a minimum of 10 that corresponds to 86% and 29% of Q_{MR}. Thus 57% is the difference between subjects with the highest and the least metacognitive regulation!
With respect the true responses for the Q_{MR} questions of metacognitive knowledge we found: Based on *N*, the mean is 15.4 and the median is 16. The range is 20 from a maximum of 24 and a minimum of 4 that corresponds to 96% and 16% of *N*, so the difference is 80%. It confirms: there are some nearly unknown metacognitive practices (e.g., *#28*: "*I find myself analyzing the usefulness of strategies while I study*") and some common learning patterns (e.g., *#52*: "*I stop and reread when I get confused*").
Our metacognitive student model provides key findings, such as: Although an average of 63% of metacognitive awareness is found out between volunteers, the range of the sample goes from 37% up to 85%. So the group of college students is *unbalanced*.
As a future work we plan: to refine the questionnaire and retest the sample. Moreover, we like to get the score of the subjects accomplished by volunteers and make a correlation between academic facts and the level of metacognitive awareness.

Acknowledgements

The first author gives testimony of the strength given by his Father, Brother Jesus and Helper, as part of the research projects of World Outreach Light to the Nations Ministries (WOLNM). The research holds a partial support from grants: CONACYT-SNI-36453, CONACYT 118962-162727, CONACYT 118862, SIP-20110398, IPN-COFAA-SIBE, IPN-SIP-EDI: SIP/DI/DOPI/EDI-0505/11.

References

[4] Flavell, J. H. (1976). Metacognitive aspects of problem solving. In L. B. Resnick (Ed), *The nature of intelligence* (pp.231-236). Hillsdale, NJ: Erlbaum

[6] Gama, C. A. (2004). *Integrating Metacognition Instruction in Interactive Learning Environments*. PhD Thesis, University of Sussex. Sussex, UK.

[3] Fernandez-Duque, D., Baird, J. A., & Posner, M. I. (2000). Executive attention and metacognitive regulation. *Consciousness and Cognition*, 10, 288–307.

[18] Schraw, G., & Dennison, R. S. (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology*, 19, 460–475.