THE DEVELOPMENT OF A QUESTIONNAIRE ON METACOGNITION FOR STUDENTS IN SECONDARY SCHOOL

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Abstract

Interest in the role of metacognition has been steadily rising in most forms of education. The present paper focuses on the construction of a questionnaire for measuring metacognitive knowledge, metacognitive regulation and metacognitive responsiveness among Secondary school students and the subsequent process of testing to determine its validity. The questionnaire was administered to 4119 students, (230 school classes) in various types of schools in Palermo, Italy. The general aim of the study was to reveal the effects of teaching specific learning strategies to students on their metacognitive knowledge, their use of metacognitive skills, and their success. The data gathered were analyzed by means of a generalization study and a decision study.

Keywords: Metacognition, Technology enhanced learning, the Awareness Learning Metacognitive (ALM) Inventory.

1 INTRODUCTION

Metacognition consists of two components: knowledge and regulation. Metacognitive knowledge includes knowledge about oneself as a learner and the factors that might impact performance, knowledge about strategies, and knowledge about when and why to use strategies. Metacognitive regulation is the monitoring of one's cognition and includes planning activities, awareness of comprehension and task performance, and evaluation of the efficacy of monitoring processes and strategies.

Metacognition has proven to be a particularly useful strategy for such settings that involves awareness and regulation of cognitive processes. Promoting the development of metacognitive skills encourages students to anticipate, monitor and reflect upon their own cognition and can lead to better engagement with learning materials. It can support students in developing their metacognitive skills in further learning or performance situations and in monitoring activity that takes place during critical performance events.

Assessment of metacognition is challenging for a number of reasons: (a) metacognition is a complex construct; (b) it is not directly observable; (c) it may be confounded with both verbal ability and working memory capacity; and (d) existing measures tend to be narrow in focus and decontextualized from in school learning.

The present paper focuses on the construction of a questionnaire for measuring metacognitive knowledge, metacognitive regulation and metacognitive responsiveness among Secondary school students and the subsequent process of testing to determine its validity.

The aim of the study was to construct an original instrument for measuring features of metacognition, henceforth referred to as the Awareness Learning Metacognitive (ALM) Inventory, and further to establish the similarities and differences between this model and existing instruments for measuring metacognition. The ALM Inventory was distributed to 4119 students, (230 school classes) in various types of schools in Palermo, Italy.

The ALM Inventory instrument was constructed on the basis of a facet design along two dimensions: components of metacognition and topics related to the use of ICT in students attending Secondary school. The data gathered with the instrument were analysed by means of a generalization study and a decision study.

The general purpose of this study is to reveal the effects of teaching specific learning strategies to students on their metacognitive knowledge, their use of metacognitive skills, and their success. The following hypotheses were developed to realize this general purpose.

1. Teaching of learning strategies increases awareness of learning strategies.

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2. Teaching of learning strategies increases metacognitive knowledge.
3. Teaching of learning strategies enables the use of metacognitive skills.
4. The use of metacognitive skills increases success

Special attention has been focused on metacognition as the interface between cognition and affect and its essential role in self-regulation in achievement settings.

2 THEORETICAL BACKGROUND

2.1 Metacognitive knowledge and regulation of cognition

Some studies [1] provide evidence to show that not all students have the ability to regulate and deploy certain key strategies during their learning. However, the presence of a tutor who assisted them in establishing goals and using effective strategies for regulating their learning, created a significant improvement in learning. Students who were given a list of goals to guide their learning were less effective at regulating their own learning.

Planning involves identification and selection of appropriate strategies and allocation of resources, and can include goal setting, activating background knowledge, and budgeting time.

Monitoring or regulating involves attending to and being aware of comprehension and task performance and can include self-testing. Finally, evaluation is defined as “appraising the products and regulatory processes of one’s learning,” and includes revisiting and revising one’s goals [2].

Additionally, in the literature it’s reported that despite the different characteristics of students, metacognitive support can improve learning [3].

An understanding of learning styles, such as being aware of one’s own learning processes and operating control over learning strategies, can be used to support or increase metacognitive awareness [4]. Students can use different learning styles to select different learning pathway through materials, accessing and processing information that influence the quality of learning process [5]. For instance, some students may understand information better by watching or listening, others by reading, and others by doing and moving or through practical work in a hands-on environment [6].

Finally, several researchers highlight the link between metacognition and motivation [7, 8, 9, 10, 11, 2, 12].

Motivation and students’ learning styles are additional important factors that influence learning [13]. Some scholars (for example [7]) note that metacognition includes affective and motivational states. Similarly, [9] argues that metacognition entails the management of affective states, and that metacognitive strategies can improve persistence and motivation in the face of challenging tasks. [10] concur, arguing that affect is an inevitable element of metacognition, because as students monitor and appraise their own cognition, they will become more aware of strengths and weaknesses. Gottfried defines “academic” motivation in particular as the “enjoyment of school learning characterized by a mastery orientation; curiosity; persistence; task-endogeny; and the learning of challenging, difficult, and novel tasks” [10, p. 525]. In the context of metacognition, motivation is defined as “beliefs and attitudes that affect the use and development of cognitive and metacognitive skills” [2, p. 112]. According to [2] motivation has two primary subcomponents: (1) self-efficacy, which is confidence in one’s ability to perform a specific task and (2) epistemological beliefs, which are beliefs about the origin and nature of knowledge.

[8] reviews the research on young children’s emotion-related self- regulation, which is the set of “processes used to manage and change if, when, and how one experiences emotions and emotion-related motivation and physiological states and how emotions are expressed behaviorally” (p. 681). This emotion-related self-regulation refers to monitoring and regulating the impact of emotions and motivational states on one’s performance and parallels the regulation of cognition involved in the executive functioning dimension of metacognition.

2.1.1 Development of Metacognition Over Time

[14] characterizes development of metacognition as the very gradual (and not always unidirectional) movement to acquire better cognitive strategies to replace inefficient ones.

[15] note that young children have difficulty monitoring their thinking during task performance and constructing metacognitive theories frameworks that integrate cognitive knowledge and cognitive regulation. Planning also appears to be a late-developing skill, with dramatic improvements in the ability to select appropriate strategies and allocate resources not appearing until 10-14 years of age.

Several researchers have concluded that metacognitive abilities appear to improve with age [7, 16, 17, 18, 19, 15]. Specifically [15] suggest that metacognitive development proceeds as follows: cognitive knowledge appears first, with children as young as age 6 able to reflect on the accuracy of their cognition, and consolidation of these skills typically evident by 8-10 years of age.

Ability to regulate cognition appears next, with dramatic improvements in monitoring and regulation appearing by 10-14 years of age in the form of planning. Monitoring and evaluation of cognition are slower to develop and may remain incomplete in many adults. Finally, the construction of metacognitive theories appears last (if at all). These theories allow for the integration of cognitive knowledge and cognitive regulation.

Students spontaneously construct these theories as they come to reflect on their own thinking and learning. Metacognitive theories tend to originate within a particular domain, and to gradually extend to other domains. These theories begin as implicit and informal, becoming more systematized and formalized over time.

2.1.2 The measurement of metacognition

One of the basic problems of the study on the field of metacognition is to develop and use valid tasks in order to measure metacognitive ability. [20] believes that using the term metacognition to refer to two distinct areas of research makes the research procedure more difficult and creates confusion clouding interpretation of research findings. Although several methods of measuring metacognition have been implemented each method has advantages and disadvantages. For example, one of the most popular approaches for assessing both metacognitive knowledge and control is to ask students directly about what they know or what they do. For assessing metacognitive control participants may be asked to think aloud about what they are doing and thinking as they solve a problem.

Nevertheless verbal reports are subject to many constraints and limitations. Asking young students about their cognitive processing can produce some special problems. Answers may reflect not what the child respondents know or do not know, but rather what he/she can or cannot tell to the interviewer. On the other hand, metacognition is cognitive in nature rather than behavioural and consequently, self-report inventories are, in some ways, the least problematic technique to measure metacognitive ability [21].

A study to measure students' self-regulation was carried out by [20] who employed learning diaries, which were collected at the end of each week, to structure a series of questions regarding events during a study session. Students were asked to complete a questionnaire that included items about motivation and learning strategies at the outset and at the end of the study. The control group of students were asked to complete a pre-test and a post-test but did not receive self- regulatory training or use the diaries. [20] reported that students who received self- regulatory training displayed significant improvements in intrinsic motivation, self-efficacy, effort, attention and self-motivation areas whereas those in the control group showed only increases in self- motivation.

2.2 Impact of Metacognitive Awareness in Technology Enhanced Learning Environments

With the advent of internet technologies and the closer integration of mobile and ubiquitous devices, learning and teaching has changed the way we view the learning process. Indisputably, there are many ways of using technology to support students' learning which enables them to manage the pace, time and place of their learning. The emergence of the internet and latest Information and Communication Technologies (ICT) have brought a whole new dimension to almost every aspect of society and in particular, to higher education. Learning and teaching in many disciplines now occurs within technology enhanced environments. ICT is used as a means for engaging in such activities as communication, socialisation, networking and researching but its unique affordances provide new approaches to the design of interactive learning environments. In such environments, there are many factors that can influence learning. The literature refers to this as self-directed and self-regulated learning.

Students can take more control over their learning and develop leadership of their own 'learning curve'. Self-directed learning includes management of the learning materials, monitoring learning progress and regulating cognitive learning styles. However, this requires students to develop metacognitive strategies so they can identify their own learning styles in the appropriate formal and informal learning situations.

A study by [1] investigated whether undergraduate students could regulate their own learning about the circulatory system using a hypermedia environment. Results demonstrated that students who regulated their learning by using effective strategies, monitored their understanding, and adapted their time and effort, showed a significant improvement in their learning. By contrast, those who used less effective learning strategies limited their ability to manage their metacognitive monitoring activities and failed to show a significant improvement in their learning [1].

[22] state that "many students lack the self-regulated learning strategies needed to be successful in these types of learning activities". Self-regulated learning is a form of metacognitive guided learning whereby students set learning goals for themselves, monitor their progress, regulate and control their cognition [1]. Self-regulation is the ability to develop knowledge, skills and attitudes that can be transferred from one learning environment to another as well as to a leisure and work environment [23] ... Students who are aware of their learning strengths and weaknesses are self-regulated students [24].

Technology enhanced learning can place students at the centre of the learning process, but this means that students need to take more responsibility for their learning. Self-regulated students can organise, manage and adapt their thoughts into skills that are required for learning. They continuously monitor their progress towards a goal or outcome and redirect efforts when necessary [25].

Students need to be aware of their own thought processes and monitor the effectiveness of their learning strategies to develop an ability to self-regulate [20]. Furthermore, it is essential that students attain strategies such as identifying the main points in a given task, asking questions or dealing with a task from start to finish [26], and be motivated to use developed or newly acquired self-regulatory strategies effectively.

3 THE ALM (AWARENESS LEARNING METACOGNITIVE) INVENTORY AND ENVIROMENT

3.1 Introduction

The questionnaire is the basis of a specific teaching methodology aimed at enhancing student metacognitive skills.

Teachers can design and implement their activities, basing on an examination of student answers. Analyzing student responses to individual items made it possible to gather more specific information about students' self evaluation of strengths and weaknesses concerning their studying methodology.

The transformation in the numbers of responses to the items, which describe a "positive behavior", allowed us to identify the existence of generalized difficulty of study when the average score is significantly lower than 2.5. The results confirmed that student motivation and methodology depends from the teaching methodology.

We asked teachers to reflect on student answers, analyzing specifically the problems and difficulties that students encounter most frequently when studying. This reflection should help them re-think the way they teach.

3.2 The ALM Inventory

In this paragraph we present the questionnaire and the results of the its administration to 4119 students, (230 school classes) in various types of schools in Palermo, Italy

QUESTIONNAIRE ALM (Awareness Learning Metacognitive) 2014

1 point is assigned to the answer "Almost never," 2 points to the answer "Sometimes", 3 points to the answer "Often," 4 point to the answer "almost always." The responses to the various items must be written in the corresponding parts (scale) of the following grid. To obtain the scale score all the point's of the items that compose it will be added up.

	Teorical points		
ALM 2014 SCALE	Min. points	max. points	Average
A motivated commitment	16	64	40
B responsible learning	17	68	42,5

	points		
ALM2014 SCALE	Min. points	max. points	Average
A motivated commitment	20	63	45,2
B responsible learning	17	68	45,1

A1 motivated commitment

1. I often speak, both at home and outside, with pleasure of the things that I do at school

	Frequency	**Percentage**	**Valid Percentage**	**Cumulative Percentage**
almost never	167	4,1	4,1	4,1
some-times	2248	55,5	55,5	59,5
often	1135	27,6	27,6	87,1
Almost always	533	12,9	12,9	100,0
Total	4119	100	100	

2. Even if I'm tired I don't give up if I have not finished what I had set out to do.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	408	9,9	9,9	9,9
some-times	1450	35,2	35,2	45,1
often	1247	30,3	30,3	75,4
Almost always	1014	24,6	24,6	100,0
Total	4119	100,0	100,0	

3. Before starting to study I reflect on the meaning of what I am going to learn.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	452	11,0	11,0	11,0
some-times	1332	32,3	32,3	43,3
often	1296	31,5	31,5	74,8
Almost always	1039	25,2	25,2	100,0
Total	4119	100,0	100,0	

4. In the classroom I am able to use the technological tools and resources in the best way.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	52	1,3	1,3	1,3
some-times	930	22,6	22,6	23,8
often	1527	37,1	37,1	60,9
Almost always	1610	39,1	39,1	100,0
Total	4119	100,0	100,0	

5. I work hard even when I do not like what I'm doing.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	297	7,2	7,2	7,2
some-times	1553	37,7	37,7	44,9
often	1308	31,8	31,8	76,7
Almost always	961	23,3	23,3	100,0
Total	4119	100,0	100,0	

6. I think that what I learn by studying could be useful for others one day.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	425	10,3	10,3	10,3
some-times	1321	32,1	32,1	42,4
often	1266	30,7	30,7	73,1
Almost always	1107	26,9	26,9	100,0
Total	4119	100,0	100,0	

7. In order to satisfy my personal interests, I sometimes look for more information about a topic presented during the classes, using multimedia resources.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	674	16,4	16,4	16,4
some-times	2114	51,3	51,3	67,7
often	886	21,5	21,5	89,2
Almost always	445	10,8	10,8	100,0
Total	4119	100,0	100,0	

8. I seriously try to understand what the teacher says even if I do not like the subject.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	137	3,3	3,3	3,3
some-times	1234	30,0	30,0	33,3
often	1466	35,6	35,6	68,9
Almost always	1282	31,1	31,1	100,0
Total	4119	100,0	100,0	

9. I often find pleasure in what I study.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	137	3,3	3,3	3,3
some-times	1538	37,3	37,3	40,7
often	1578	38,3	38,3	79,0
Almost always	866	21,0	21,0	100,0
Total	4119	100,0	100,0	

10. I do my best even if a task requires a lot of time and effort.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	117	2,8	2,8	2,8
some-times	913	22,2	22,2	25,0
often	1499	36,4	36,4	61,4
Almost always	1590	38,6	38,6	100,0
Total	4119	100,0	100,0	

11. When, for some reason, I fall behind with class work, I try to catch up without the teacher forcing me to do so.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	270	6,6	6,6	6,6
some-times	1095	26,6	26,6	33,1
often	1253	30,4	30,4	63,6
Almost always	1501	36,4	36,4	100,0
Total	4119	100,0	100,0	

12. One of the most important reasons that pushes me to study is the desire and curiosity to learn new things.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	164	4,0	4,0	4,0
some-times	1193	29,0	29,0	32,9
often	1516	36,8	36,8	69,7
Almost always	1246	30,3	30,3	100,0
Total	4119	100,0	100,0	

B responsible learning

13. Even if a task is tedious, I continue to do it until I have finished.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	126	3,1	3,1	3,1
some-times	857	20,8	20,8	23,9
often	1363	33,1	33,1	57,0
Almost always	1773	43,0	43,0	100,0
Total	4119	100,0	100,0	

14. When I find a problem I try to overcome it by increasing my effort.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	118	2,9	2,9	2,9
some-times	1151	27,9	27,9	30,8
often	1616	39,2	39,2	70,0
Almost always	1234	30,0	30,0	100,0
Total	4119	100,0	100,0	

15. Even when what I study is boring and not so much interesting for me, I continue to work uninterruptedly.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	338	8,2	8,2	8,2
some-times	1655	40,2	40,2	48,4
often	1327	32,2	32,2	80,6
Almost always	799	19,4	19,4	100,0
Total	4119	100,0	100,0	

16. I try to relate my study and what I learn in school with my everyday life.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	402	9,8	9,8	9,8
some-times	1528	37,1	37,1	46,9
often	1346	32,7	32,7	79,5
Almost always	843	20,5	20,5	100,0
Total	4119	100,0	100,0	

17. When I study mathematics, I do various exercises to see if I understand well.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	598	14,5	14,5	14,5
some-times	1406	34,1	34,1	48,7
often	1018	24,7	24,7	73,4
Almost always	1097	26,6	26,6	100,0
Total	4119	100,0	100,0	

18. I try to see how what I study could apply to my everyday life.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	451	10,9	10,9	10,9
some-times	1719	41,7	41,7	52,7
often	1323	32,1	32,1	84,8
Almost always	626	15,2	15,2	100,0
Total	4119	100,0	100,0	

19. When I study I try to establish connections among the different ideas presented in different resources proposed by the teacher.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	384	9,3	9,3	9,3
some-times	1706	41,4	41,4	50,7
often	1387	33,7	33,7	84,4
Almost always	642	15,6	15,6	100,0
Total	4119	100,0	100,0	

20. When I learn a new rule I reflect on its possible applications in other fields/domains/cases.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	251	6,1	6,1	6,1
some-times	1141	27,7	27,7	33,8
often	1599	38,8	38,8	72,6
Almost always	1128	27,4	27,4	100,0
Total	4119	100,0	100,0	

21. Asking my self questions helps me concentrate when I study.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	590	14,3	14,3	14,3
some-times	1386	33,6	33,6	48,0
often	1277	31,0	31,0	79,0
Almost always	866	21,0	21,0	100,0
Total	4119	100,0	100,0	

22. I ask myself if what I hear, see or read is true.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	346	8,4	8,4	8,4
some-times	1149	27,9	27,9	36,3
often	1364	33,1	33,1	69,4
Almost always	1260	30,6	30,6	100,0
Total	4119	100,0	100,0	

23. If I find difficulties in understanding what I am studying, I try to change the method.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	651	15,8	15,8	15,8
some-times	1331	32,3	32,3	48,1
often	1245	30,2	30,2	78,3
Almost always	892	21,7	21,7	100,0
Total	4119	100,0	100,0	

24. When in the classroom or in the books a theory is presented, I try to work out how it was elaborated.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	719	17,5	17,5	17,5
some-times	1708	41,5	41,5	58,9
often	1104	26,8	26,8	85,7
Almost always	588	14,3	14,3	100,0
Total	4119	100,0	100,0	

25. When studying or listening to a lecture or watching a video, I try to find links in my mind with other subjects I have previously studied.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	326	7,9	7,9	7,9
some-times	1725	41,9	41,9	49,8
often	1334	32,4	32,4	82,2
Almost always	734	17,8	17,8	100,0
Total	4119	100,0	100,0	

26. I ask myself questions to make sure I understand what I'm studying.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	311	7,6	7,6	7,6
some-times	1610	39,1	39,1	46,6
often	1445	35,1	35,1	81,7
Almost always	753	18,3	18,3	100,0
Total	4119	100,0	100,0	

27. I change my way of studying, when necessary, adapting it to the different subjects.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	479	11,6	11,6	11,6
some-times	1669	40,5	40,5	52,1
often	1361	33,0	33,0	85,2
Almost always	610	14,8	14,8	100,0
Total	4119	100,0	100,0	

28. I think that studying means to learn a subject, rather than simply reading a paragraph (o even a book) on it.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	325	7,9	7,9	7,9
some-times	1281	31,1	31,1	39,0
often	1438	34,9	34,9	73,9
Almost always	1075	26,1	26,1	100,0
Total	4119	100,0	100,0	

29. When possible, I try to connect what I study in different subjects.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	458	11,1	11,1	11,1
some-times	1775	43,1	43,1	54,2
often	1286	31,2	31,2	85,4
Almost always	600	14,6	14,6	100,0
Total	4119	100,0	100,0	

30. I try to relate new subjects to things I already know.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	291	7,1	7,1	7,1
some-times	1478	35,9	35,9	42,9
often	1454	35,3	35,3	78,2
Almost always	896	21,8	21,8	100,0
Total	4119	100,0	100,0	

31. When I learn new things or new ideas I try to imagine a situation in which they can be applied.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	411	10,0	10,0	10,0
some-times	1616	39,2	39,2	49,2
often	1264	30,7	30,7	79,9
Almost always	828	20,1	20,1	100,0
Total	4119	100,0	100,0	

32. When I search for a solution to a problem, I try to work out different possibilities, even taking into account technological tools and resources.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	261	6,3	6,3	6,3
some-times	1085	26,3	26,3	32,7
often	1473	35,8	35,8	68,4
Almost always	1300	31,6	31,6	100,0
Total	4119	100,0	100,0	

33. I try to apply what I am reading in a text to other situations.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
almost never	618	15,0	15,0	15,0
some-times	1716	41,7	41,7	56,7
often	1113	27,0	27,0	83,7
Almost always	672	16,3	16,3	100,0
Total	4119	100,0	100,0	

3.3 The ALM Environment

The methodology ALM aimed at enhancing in students that prepare to become teachers those metacognitive skills and strategies that are especially significant for their achievements and involve students' commitment and self-regulated learning.

The proposed activities were created, validated and carried out in the class both face-to-face and online.

Within ALM environments, students' achievement is influenced by the level and effectiveness of applied self-regulation techniques, or the ability to plan, monitor and evaluate their own behaviour and learning strategies. Visual cues structure the design of the interaction in a ALM environment and have the potential to make a significant difference in the effectiveness of metacognitive development. The interface design of an environment which helps students to manage the resources provides tools, supports and advice.

The ALM environment includes learner heuristics such as discussion forum, chat tools, mind-mapping and note-taking tools. It also provides additional metacognitive development activities. For example, students are asked to complete a pre-knowledge test, an information recall test and an information retention test during the experiment. While studying the subject within the ALM environment students have freedom to navigate through the learning materials which are presented in text, audio, image and video formats, and find a way of learning that suits them best.

On the one hand, students need to use metacognitive strategies to manage their learning, particularly when they are given freedom to determine how they access and use a variety of on-line resources. On the other hand, ALM environments must include relevant metacognitive and support activities by considering students' differences in skills, preferences and metacognitive needs. Finding effective ways of learning depends on two key factors: the design of a ALM environment and students' metacognitive skills. Although, most students having difficulty in regulating their learning process and strategies, there are different learning activities (i.e. wiki, concept-mapping and discussion forums) that can be utilised to encourage skills development. Future work involves the discussion of students' behaviours within a formal learning design environment where students have full control of their learning.

The generalization study showed that the reliability of the instrument was satisfactory. The decision study revealed that the number of items included in the questionnaire could be reduced substantially by leaving out two components of one of the dimensions in the facet design, without losing too much generalization.

We have been using different tools of assessment in order to monitor and evaluate initial competences, intermediate improvements and final outcomes of the project. The overall strategy aimed at improving the teaching skills of school teachers involved in the research.

Before designing the ALM exercises and the methods of evaluating the results of the intervention, it has been necessary to define the most relevant characteristics for academic success. The initial assessment of students' characteristics required triangulation, comparison and integration of information gathered from different sources.

The use of an observation grid of the learning processes, previously built and validated, allowed teachers to gain - along the way - a clear awareness of the outcomes of their teaching.

In particular, we observed:

- educational strategies to improve students' attitudes and motivations;
- actions designed to create a collaborative work climate in the classroom;
- arrangements for assessment and evaluation;
- actions for recovery and enhancement.

We also examined how teachers could use:

- training materials according to their methodology;
- online facilities for self-training (forum and video lectures managed by experts);
- the support of researchers.

3.4 The Results

Through the employment of ALM model, we wanted to highlight that the effective use of metacognitive strategies **is** an important factor contributing to critical thinking performance. The results clearly supported this proposition and threw light on how these strategies can affect thinking performance. The action-reflection ALM model is not new in formal teacher training; however, its application within the teaching work environment has only recently gained momentum in SRL development training. While there is no one learning format, project work is central to the design of the learning intervention.

There is a clear link between action, reflection and change within this style of teaching. In the activity-reflection model there are four stages to the cycle of reflection: the initial or new experience; reflection and observation; development of a new concept and experimentation. Action learning when applied in a training or education format is distinctly different due to a level of required reflection that enhances teaching. In reflecting, the teacher engages in active, persistent and careful consideration of ideas to seek a deeper understanding and a broader and more reasoned point of view.

In a web forum students were introduced to the need to create and establish an emotionally supportive environment in which they feel “safe” and have the confidence to reveal how they think. The expression of personal material in reflection can be threatening. What might seem threatening to one person might seem fine to another. There is a need to recognize and respect each other’s differences, bearing in mind that the purpose in being reflective in this environment is for teachers to evaluate their own SRL development.

4 CONCLUSION

In this paper we have discussed the factors that are required to help students gain the full benefits of learning within ALM environments. The ALM Inventory is a reliable and valid instrument for measuring metacognitive knowledge, regulation and responsiveness. It is suitable for use in the evaluation of the effects of interventions aiming at increasing metacognitive knowledge, regulation and responsiveness in students attending Secondary school. The success of a ALM environment depends as much on the details of how tools, content and support are implemented and visually presented as on the simple fact of their presence. For example, discussion forums and chat rooms will not be used if students do not notice them. Content will not be visited if the links which identify them are not well marked. Students need to actually notice the information first, and then to recognise that it is important.

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