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Amelioration of the Relationships Aggregating Educational Entities in Recursive Entity Modeling Method

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Abstract

After recursive entity modeling method conception; we aim to convert it to a notation language executable on computer platforms, but the case studies performed on learning scenarios adopting different pedagogical strategies are revealed some problems in this method; amongst them, we will interest to those related to the relationships aggregating educational entities composing a learning scenario. Indeed, there are six relationships, which can be classified into two categories; the first ones are of physical type allowing to define the position of an educational entity in the learning scenario. Whereas the second ones are of intentional type informing on the role played by an entity vis-a-vis another one in the learning scenario. Since the second type is rarely used and the first type which is always used don't give more pedagogical information on an entity position. In this work, we will proceed to revisit these relationships in order to bring more educational and semantic precisions about these relationships in order to ameliorate the REMM implementation.

Keyword: Recursive entity modeling method, Instructional design, Learning scenario, Relationships, Learning entity

1. INTRODUCTION

With the evolution of information and communication technologies, new horizons were opened to computerize teaching and learning platforms; which gave birth to e-learning mode. In terms of theoretical research, several approaches have emerged in order to improve methods and tools used in this new mode.

On another side, to insure the conception and the sharing of high quality distance courses, several specifications were developed, namely Learning Object Metadata [1], Method Engineering Learning Systems (MISA) [2] and IMS Learning Design language (IMSLD) [3]... Each one of them adopts a different approach, LOM is based on the documentalist approach, MISA uses the process approach whereas IMSLD is based on the activity approach and learning courses design.

However, although these specifications have many advantages such as ensuring continual stimulation of learners motivation [4], several limitations have been reported in various researches [5] such as lack of the pedagogical neutrality, difficulty to understand and use them by designers, difficulty to reuse the designed models in different contexts… . So to overcome these problems; we have conceived a learning modeling method named " recursive entity modeling method" based on the existing specifications [6]. This method has been implemented successfully through cases studies of learning scenario adopting different educational strategies [7] [8] but it still needs some improvements. In the paper [9], we have firstly revised the concept of sequence; and consequently, rectified the "Roles", "components" and "Conception" elements in order to ensure more expressive and meaningful scenarios design, and also easiness of both the pedagogical designers work and the design of a notation language based on REMM.

In this work, we will focus to correct the problems revealed at the REMM's relationships level. In fact, there are six relationships which are divided into two categories, the first one is of physical/structural type allowing to conceive the learning scenario architecture by defining the position of an entity with respect to others, whereas the second one is of intentional type informing about the pedagogical role played by an entity vis-a-vis to others into the learning scenario. But in all conducted learning scenario cases studies [7] [8], we remarked that we give more importance to physical relationships than the intentional ones; which makes the learning scenario pedagogically less significant. So, the goal of this paper is to overcome to this problem by revisiting the REMM's relationships.

The rest of this paper is organized as follows: in the second paragraph, we will present the concept of educational design and learning scenario, and discuss the educational scenarios modeling according to IMS LD, in the first time, by defining the limitations raised into its structure, and in the second time, according to REMM by specifying its strengths. In the third paragraph, we will elucidate the problems raised into educational scenarios modeling by REMM, specially those corresponding to the relationships aggregating educational entities, and then, we will propose some rectifications to overcome these limitations and discuss the results of relationships modifications. Finally, we will end with a conclusion.

2. Instructional design and Learning scenario modeling

2.1. Instructional design and learning scenario notion

According to [10], the pedagogical scenario was known under different names: "pedagogical design" [11], "instructional design" [12] [13], "learning engineering", "teaching planning"[14] and "instructional design"[15]. Its origin stems from audiovisual field which consists to stage a written text, whether theatrical, literary or cinematographic, in order to give life to the writings by putting the events, movements and characters in a multidimensional setting allowing to the viewer to live the experience [16].

The educational scenario is the result of instructional design process [10]. According to Paquette et al [17], it consists of learning scenario and support scenario, describing an activity or activities of learning and assistance, as well as the resources required to support activities and resulting from activities. As for Daele et al. [18], they considered it as the result of a learning activity conception process within a given time and leading to the implementation of the scenario. Thus, in one scenario, we find the goals, planning of learning activities, a schedule, a description of student tasks and evaluation of methods which are defined, organized and arranged in a design process. While Pernin and Lejeune [19] have defined it as a priori and posteriori description of the learning situation progress for the appropriation of a specific set of knowledge, by specifying the roles, activities, resources, tools, and services related to the implementation of activities.

2.2. Learning scenario modeling according to IMSLD

2.2.1. Conceptual model of learning scenario

IMS LD [3] is a specification borrowed from the theater field which takes back the terminology used in OUNL EML model [20] to describe a learning unit. It considers that a learning unity model is composed of the following three components:

- Objectives and prerequisites : set the framework to use in term of knowledge or skills;
- Components : describe the necessary entities for the implementation of the learning unit;
- Method : describes the course of the learning unit

So the IMS LD conceptual model of a learning scenario can be illustrated by the following class diagram:

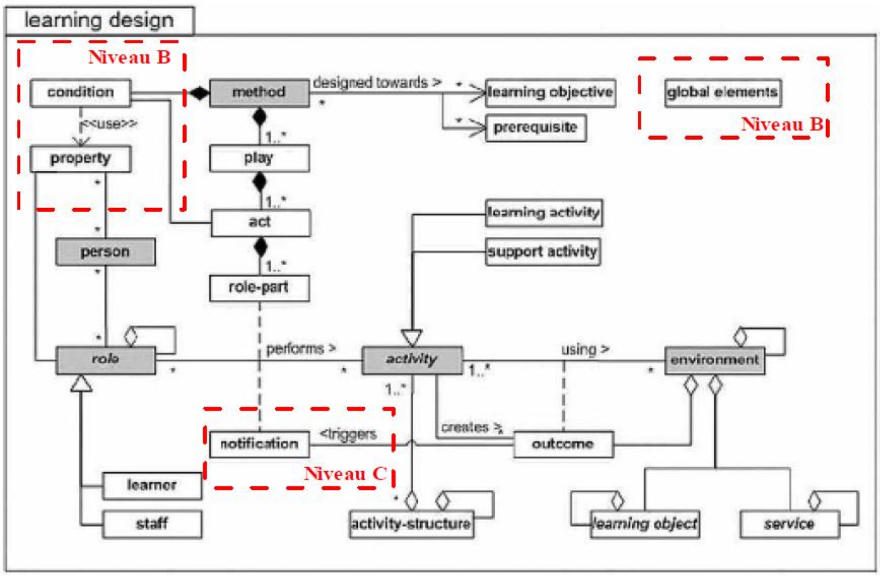

Figure 1: IMS LD conceptual model of learning scenario [21]

IMS LD allows the design of learning units on three levels designated by letters A, B and C. The first level "A" defines all elements shown in figure 1, except properties, conditions, and notification; that which prohibits customization of the courses in a learning unit and consequently produces an identical execution diagram from one session to the other for each person in a given role. Concerning level B, it introduces conditions and properties elements in learning scenario model, which allows both the personalization of learning units and the more finesse in the planning of mandated tasks. Wheras level C, it introduces the concept of notification representing an action triggered on the occurrence of a particular event such as: the termination of an activity, act, or a part of the learning unit, the condition verification and the property modification [21]. So it defines a priori treatments in response to certain events observed during the learning unit execution.

As shown in figure 1, the element ''Method'' is composed by the following elements:

- Parts (Plays): they are equivalents to educational scenarios logically independents and executed in parallel processes. Several Parts may be defined to model differentiated courses which may correspond, for example, to two different populations following the same training courses, one in face-to-face and the other in distance mode [21].
- Act: each part is divided into acts performed in sequence.
- Partition: each act is composed of a set of partitions; each one of them attributes a role to an activity. The partitions must be run in parallel way, and the same role can be involved only once in the same act. The partition concept defines the activities regardless of roles which ensure their reuse: thus, an activity can be assigned to different roles within the same act, as well as to same role within various acts of a play. Figure 2 below outlines the execution scheme of parts, acts and partitions: (two vertical parallel lines express the running in parallel way; whereas a horizontal arrow expresses the running in sequence way).

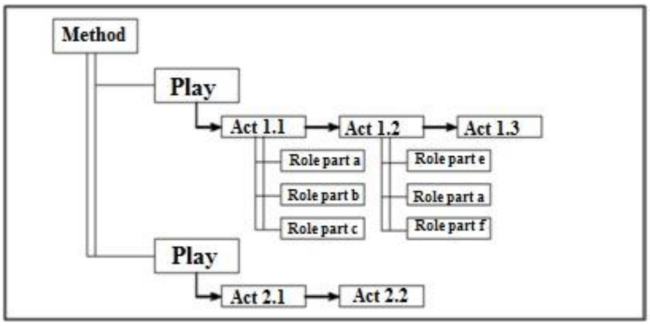

Figure 2: Executing Scheme of elements composing the element ''Method'' [20]

2.2.2. Discussion of the IMSLD learning scenario structure

Nodenot [5] reported several limitations related to IMSLD specification. Amongst them, we specially focus on IMSLD learning unit structure since it is constraining for many reasons, namely:

- The plays are required to be performed in parallel way
- The acts are necessarily arranged in sequence way
- The partitions, which define the roles independently to activities, are always executed in parallel way
- The structured activities represent a set of basic activities (support activities and/or learning activities) that can be performed sequentially or by selection).

So, we can clearly note that IMS LD provides a very firm structure, by offering the means describing the processes in parallel way (Play, role-part, structured activity, act) without permitting their synchronization [5]; which constrains on the one hand their reuse and adaptation to different contexts; and on the other hand, the understanding of the learning unit by the learners.

2.3. Learning scenario modeling according to REMM

2.3.1. Conceptual model of learning scenario

REMM [6] is a meta-model allowing both the modeling of educational situations and their referencing by a set of metadata and components (LearningContent, SupportElement, Service, Tools, Roles, Conception…) within a pedagogical entities.

REMM considers two classes of pedagogical entities, namely: elementary and composed entities.

The first ones are of two types:

- Activity : represents the case of modeling of pedagogical situation whose the goal is elementary obtained by carrying out one task by one or several pedagogical roles (Learner or Supervisor);
- Sequence, consists of the modeling of a pedagogical situation whose the goal is elementary reached by realizing several tasks assigned to roles of the pedagogical situation modeled as part of the sequence.

The composed entities are also of two types:

- Block: represents the modeling of pedagogical situation of an average granularity. It can be composed of other blocks and/or sequences and/or activities. Its objective is explicit, complete and determined in terms of knowledge and skills for a specific public.
- Unit: represents the highest granularity of a pedagogical situation. It can be composed of other units and/or blocks and/or sequences and/or activities to approach a specific learning subject for a specific public. The unit can designate a course, a module, a unit of study, a semester, a license, a master, a project, etc.

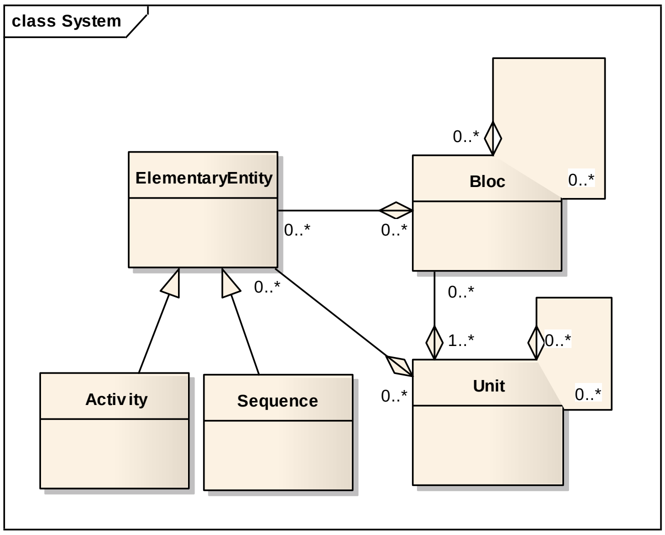

Figure 3: Educational unit class diagram [9]

2.3.2. Learning entities aggregation relationships

The elementary entities include tasks while the composed ones contain entities hierarchically lower or equal to them, called girls entities. These ones must be aggregated with six types of relationships to compose the learning situation scenario progress. These relationships are:

- Precedence: permits to execute the entities in sequential way
- Hierarchy: expresses the case when a learning entity is described in detail by another one;
- Simultaneity: allows realizing several entities at the same time;
- Extension: allows superimposing several learning scenarios whose the execution is conditional.
- Accompaniment: permits expressing the assistance situations to learner works such as : a feedback of the accomplished evaluations, of the real learning situations …)
- Choice: allows choosing the entities to be realized according to specific conditions related to the previous learning results or to other circumstances.

2.3.3. Learning scenario expression according to REMM

In the REMM, the "Conception" component describes the structure of the learning scenario modeled into the pedagogical entity. In fact, it shows the manner in which the entities girls are aggregated, by specifying the relationships and conditions governing them.

The scenario can either be a task (if an entity is of activity type), an entity (component "Entity_unique"), a path or a node that we detail as follows:

a. "Entity_Unique" corresponds to the case where the entity is composed of a single entity girl. This latter is referenced within the scenario (component "Conception") by the local key granted to it at level of its parent entity (under the element "Components").

b. "Path": is referenced by the value assigned to attribute "PathRef" and composed of a sequence of links (the component "Connection"), each "Connection" connects two elements (defined below) in the pedagogical scenario by specifying the relationship and the condition of the first element validation allowing the second element execution. So, the "Connection" component is composed of the following sub-components and attributes:

   - "Element": it can either be a task, an entity, a path or a node. Therefore, the component "Element" may correspond to one of these four components: "Task", "Entity_unique", "Path", "Node";
   - "Relationship": is the relationship that connects the elements corresponding to the component "Connection". It can take one of the following values: precedence, hierarchy, accompaniment, extension;
   - "Condition_relation": describes the condition or conditions governing the performance of the relationship.

c. "Node": represents a control element allowing either choosing the element to achieve among two or more elements or executing two or more elements in parallel way. This component is composed of the two properties:

   - NodRef : permits to reference the node as part of the parent entity.
   - NodeRelationship: This property provides information about the relationship which aggregates the elements defined as part of the grains of the node. It can take as value "Choice" or "Simultaneity".

The node is also composed of the following subcomponent:

- Grain: defines both a single element, the condition of its execution and the relationship between this one and the other one situated into upstream of the node. To express this information, the "Grain" component includes the following subcomponent and properties:
  - Element (previously defined under component "Connection")
  - OpeningCondition: the condition that allows the execution of the element corresponding to the "Grain";
  - Relation_Element_Upstream : the relationship between the element corresponding to the "Grain" and the other one located upstream of the node. It can take one of the following values: "Precedence", "hierarchy", "Accompaniment" and "Extension".

  We note that a "node" must have at least two grains.

2.3.4. Discussion of the REMM learning scenario model

By implementing REMM through case studies [7] [8], we were able to identify several strengths compared to IMS LD, namely:

- It ensures referencing and sharing of learning scenarios by using properties of different types (contextual (title), educational (learning strategy, teaching Strategy), General (authors, date, targetPublic...)
- It ensures reuse of the pedagogical entities and facilitates their update and adaptation since REMM is based on 1) assigning of values to properties to describe pedagogical situation components, 2) referencing the pedagogical entities within the scenario by local keys which are attributed to them into their parents entities, 3) update history of the entities consisting of the changes brought on learning objects, Conception element (scenario), Roles ... which makes pedagogical scenario easy to reuse and to adapt.
- It is portable on all pedagogical strategies since it ensures precise description of the scenario by defining the adopted pedagogical strategy, detailing the organization of roles, offering various kind of relationships that allows to customize learning courses and finally by providing a well-studied structure to describe the scenario unfolding which facilitates its understanding by the learners

3. PROBLEMATIC AND PROPOSED AMELIORATION

3.1. Problematic

Although REMM has presented several advantages, it's still some gaps to be corrected at level of its relationships aggregating educational entities composing a learning scenario. These ones can be grouped into two categories, namely:

- Physical relationships informing about the physical position of an educational entity within the learning scenario such as precedence, simultaneity and choice relationships
- Pedagogical relationships expressing the pedagogical intention of introduction of an element (Entity_unique, Task, Path or Node) in the scenario with respect to another element (Entity_unique, Task, Path or Node) such as hierarchy, extension and accompaniment relationships;

According to the case studies carried out in previous works [7][8], we remarked that during the conception of a learning scenario, one always uses "physical" relationship (precedence, simultaneity or choice) to aggregate learning scenario entities without giving importance to the pedagogical property of the relationship. For example, considering the case of a sequence (referenced by Sequence01) which discusses briefly a topic and a block (referenced by BLOCK012) detailing it further and supposing that in the actual scenario, the learner has the choice to select the execution of the one or the other entity. According to REMM, this case is expressed by a node connecting the two entities Sequence01 and BLOCK012 (which are defined within grains) with the relationship of choice according to a specific condition instead of the relationship of hierarchy which explains that BLOCK012 details Sequence01. This example shows on the one hand that the relationships of hierarchy, extension and accompaniment are rarely used in learning scenario and on the other hand that the relations precedence, simultaneity and choices are not quite sufficient to enrich the pedagogical aspect of the learning scenario.

3.2. Proposed rectifications on the relationships

To remedy the problem raised into REMM relationships, we decided to aggregate the learning scenario entities at the same time by the physical relationships (precedence, simultaneity and choice) and the pedagogical relationships (hierarchy, extension and accompaniment) in order to give more pedagogical explanations on the role played by an entity in the learning scenario. So, in the following, each components of the element "Conception" will be discussed, by specifying the relationships between the component "Element" into the components "Connection", "Node" and "Grain".

3.2.1. "Path" component

The component "Path" allows executing sequentially two or more elements. It is composed of subcomponents and attributes explained below:

- "PathRef": whose the role is to reference the "Path" by a unique value at level of the educational entity,
- "Connection" (one or more) composed in turn of:
  - ConnRef: allows referencing the connection into the parent entity.
  - Element (two elements): an element can either be ''Entity_Unique'', ''Task'', ''Path'' or ''Node''. So, this component is composed of the following attributes:
    - ElementRef: allows referencing the element within its parent entity
    - ElementType: permits to define the type of the element. It can take one value amongst the values: Task, Entity_unique, Path or Node.
  - Relationship: this component defines the physical and the pedagogical relationship aggregating the elements of the component "Connection". So, it is composed of the following attributes and sub-components:
    - RsRef: permits to reference the Relationship by a unique value.
    - SourceElementRef: it represents the first performed element into relationship component regarding PhysicalRelationship sense.
    - TargetElementRef: it represents the second performed element into relationship component regarding PhysicalRelationship sense.
    - PhysicalRelationship: allows to aggregate the source and the target elements by the relationship of "Precedence" or "ComplexRelationship"; this second value expresses the case where one or the two elements into "Connection" are of "Node" type; and the element corresponding to each grain of the node is aggregated with the element

which is outside (up/downstream) of the node with a different relationship.

- PhyRelSCondition: it represents the condition of the validation of the PhysicalRelationship (the validation of the element defined into SourceElementRef in order to execute the element referenced into TargetElementRef).
- PedagogicalRelationship: allows informing about the pedagogical relationship between the elements corresponding to the component "Connection" by specifying the educational role played by an element vis-a-vis the other one. It is composed of the attributes:

- PedagogicalRelationshipValue: it can take one of the values: "Undefined" (if the two elements haven't connected by a pedagogical relationship), "Hierarchy", "Extension", "Accompaniment" (their definitions are introduced by REMM) or "ComplexRelationship" (if one or two elements into "Connection" are of "Node" type; and the element corresponding to each grain of the node is aggregated with the element which is outside (up/downstream) of the node with a different relationship).
- RsDir: permits to inform about the source and the target element regarding PedagogicalRelationship. It can take as value: *Normal*: if the source element and the target one are those defined respectively by SourceElementRef and TargetElementRef regarding PedagogicalRelationship. And *Reverse*: if the element referenced into TargetElementRef is the source element and the element referenced into SourceElementRef is the target element regarding PedagogicalRelationship.
- PedRelSCondition: expresses the condition of execution of the pedagogical relationship

The class diagram illustrating the rectified component "Path" is shown in figure 4 below:

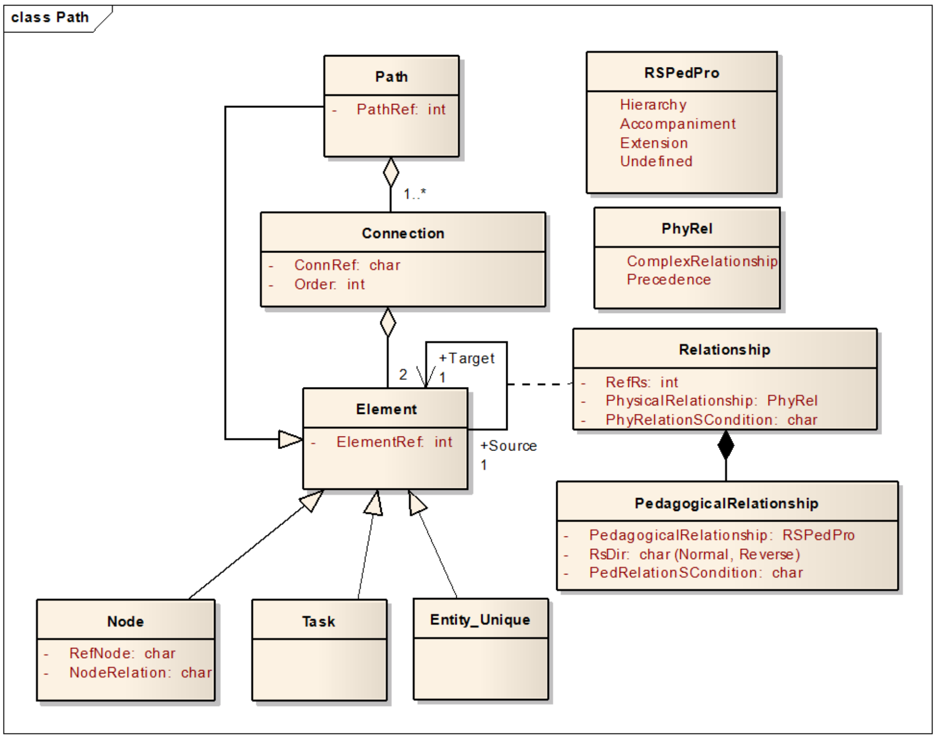

Figure 4: Class diagram illustrating the rectified component "Path"

3.2.2. Node

The component ''Node'' plays the role of a control element expressing the two following cases:

- Selection of an element amongst of several
- Execution of several elements in parallel way.

Consequently, it is composed of the following attributes and components:

- NodeRef : allows to reference the node within the parent entity
- NodeRelationshipType: takes as value the type of the physical relationship aggregating the elements attributed to the grains of the node. So, it can take one of the two below values:
  - Simultaneity: corresponds to case of the parallel execution of the elements of the node grains.
  - Choice: corresponds to case of the selection of the element to be executed amongst those defined into the node grains.

- Grain (two or more), whose the attributes and components are:
  - GrainRef: allows referencing the grain within the parent entity.
  - OpeningCondition : indicates the condition permitting the execution of the element of the grain
  - Element: represents the element to execute. It is composed of the following attributes:
    - ElementRef: allows referencing the element within its parent entity
    - ElementType: permits to define the type of the element. It can take one value amongst the following values: Task, Entity_unique, Path or Node.

We note that the element corresponding to each grain of the node can be related with the elements corresponding to others node grains by a pedagogical relationship (by considering that the physical relationship is already defined into component "Node"), and also with the elements situated into outside of the node by a physical and pedagogical relationship. So, the component "Grain" is composed also of the sub-components "PedagogicalRelationship" in order to express the pedagogical relationship between elements of the node grains and "Relationship" for expressing the relationship between the elements of the node grains and those situated outside of the node. These sub-components are detailed below:

- PedagogicalRelationship: allows informing about the pedagogical relationship between elements corresponding to grains of the node. It is composed of the attributes:
  - PedagogicalRelationshipValue: it represents value of the pedagogical relationship which can take:
    - "Undefined": if two elements are not connected by a pedagogical relationship,
    - "Hierarchy", "Extension", "Accompaniment", defined in subsection 2.3.2
  - SourceElementRef: it represents the first element into pedagogical relationship.
  - TargetElementRef: it represents the element into pedagogical relationship which represents the property defined into PedagogicalRelationshipValue vis-a-vis the element defined into SourceElementRef.
  - PedRelSCondition: expresses the condition of the pedagogical relationship execution
- Relationship: allows defining the physical and pedagogical relationship between the elements corresponding to grains of the node and those situated into outside of the node. So, this component is composed of the following attributes and sub-components:
  - RsRef: permits to reference the component "Relationship" by a unique value.
  - PhysicalRelationship: in general, this attribute takes the value of the physical relationship defined at level of the component "Connection" which aggregates the node with the second element, but if the value of the relationship is different for element corresponding to grain of the node, so, it can take one of the following relationships: "Precedence", "Choice", "Simultaneity" defined in subsection 2.3.2.
  - SourceElementRef: it represents the first element into relationship component regarding PhysicalRelationship sense.
  - TargetElementRef: it represents the second element into relationship component regarding PhysicalRelationship sense.
  - PhyRelSCondition: expresses the condition of execution of the physical relationship
  - PedagogicalRelationship: allows informing about the educational relationship between the node grains elements and those situated into outside of the node. So, It is composed of the attributes at below:
    - PedagogicalRelationshipValue: it can take one of the values:
      - "Undefined": if the two elements haven't connected by a pedagogical relationship,
      - "Hierarchy", "Extension", "Accompaniment", defined in subsection 2.3.2
    - RsDir: permits to inform about the source and the target elements regarding PedagogicalRelationship. It can take one of the values: Normal: if the source element and the target element are referenced respectively by SourceElementRef and TargetElementRef; and Reverse: if the element referenced by TargetElementRef is the source element and the element referenced by SourceElementRef is the target element regarding pedagogical relationship (the target element is that which represents the PedagogicalRelationshipValue property vis-a-vis the source element)
    - PedRelSCondition: expresses the condition of the pedagogical relationship execution.

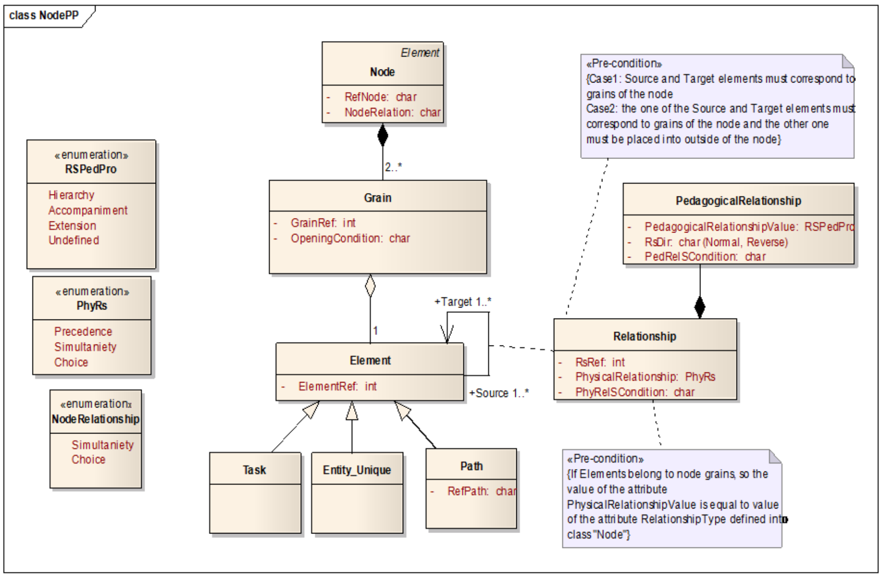

Figure 5: Class diagram illustrating the rectified component "Node".

In the figure 5 below, we present the class diagram of the rectified component “Node”:

So according to the two previous class diagrams illustrating the rectified “Path” and “Node” components, we can establish the class diagram of the component “Conception” in the figure 6 at below:

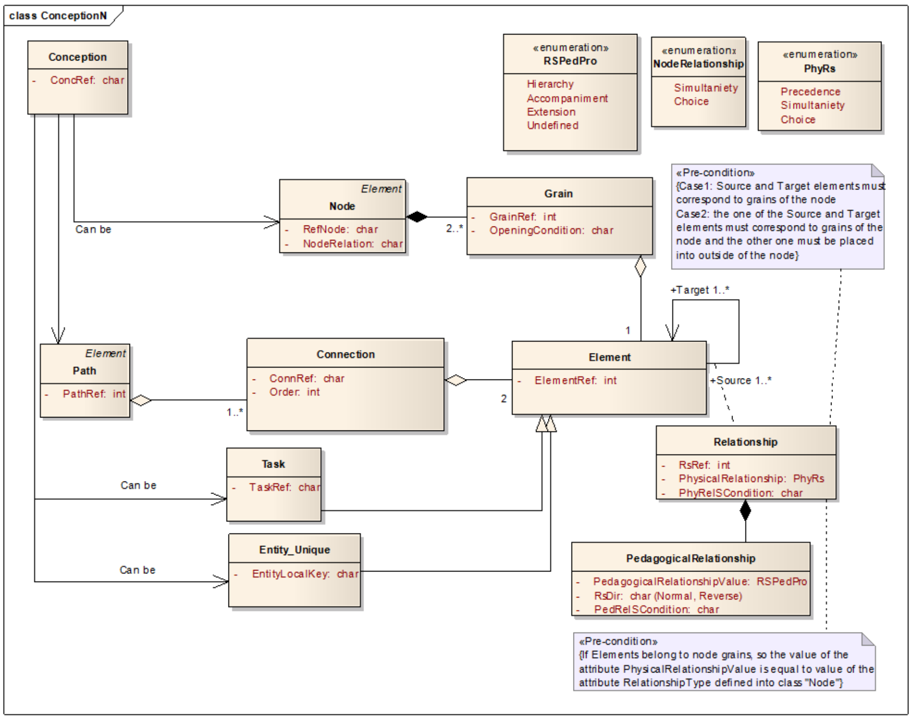

Figure 6: Class Diagram illustrating the component “Conception”

3.3. Discussion

The modifications that we have brought on the expression of the REMM’s relationships ensure the aggregation of learning scenario educational entities with two categories of relationship. The first one is of physical type comporting : precedence, simultaneity, and choice relationships which define the position of an educational entity at level of learning scenario, whereas the second one is of pedagogical type consisting on hierarchy, accompaniment and extension relationships which precise the pedagogical role played by an entity vis-a-vis another one. Thus, this improvement ensures the expression of semantic learning scenarios pedagogically more detailed and clarified.

4. Conclusion

In this work, we have revisited the relationships proposed by the recursive entity modeling method in order to clarify the physical and pedagogical relationships between entities of the pedagogical scenario. To do this, we have considered at level of a learning scenario that entities are aggregated by two types of relationships, namely:

- Physical relationship (precedence, simultaneity or choice) permitting to define physical position of an entity in the scenario,
- Pedagogical relationship (hierarchy, Extension and accompaniment) in order to explain pedagogical role of the entities defined at level of the physical relationship.

On the other hand, we have expressed in detail the relationship between the element of each node grain and the other one located outside of the node (at level of a Connection) in order to bring more flexibility at REMM to approach the complex cases and produce scenarios easy to understand.

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