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Managing Student Mobility in Cameroon's University Ecosystem: A FORM/BCS Approach

Amougou Ngoumou[1*], Atsa Etoundi Roger[2], Marcel Fouda Ndjodo[3]

[1,2,3]University of Yaounde I, BP 337, Yaounde, Central Province, Cameroon
[1]amougou.ngoumou@univ-yaounde1.cm*; [2] atsa.etoundi@ict4d.cm; [3] marcel.fouda@dite-ens.cm
* corresponding author

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Correspondence:
E-mail:
amougou.ngoumou@univ-yaounde1.cm

ABSTRACT

Nowadays, student mobility cannot be avoided in Cameroon university ecosystem. This phenomenon has many causes. Certain students live with their parents who are civil servants and they have to move with them when they are sending to a different region; another situation is link to universities newly created in cities where the cost of the live is better than in the home university city and students prefer move to these new universities. Since student circuit is not the same in each university, it is difficult to find his level in the new university and which courses he has to follow in order to complete his training. This problem is crucial in Cameroon university ecosystem and we tackle it in this paper. The Feature Oriented Reuse Method with Business Component Semantics (FORM/BCS) is a software domain engineering method that has been proposed to design an adaptable architecture for systems belonging in a same business domain. In this work, we apply the FORM/BCS method to manage student mobility in Cameroon university ecosystem. The result of this work is a management model that allows once a student gets an enrolment in a new university, to transfer credit from the student home university to the host one.

1. Introduction

This template Student mobility is the obligation of a university enrolled student to move from his actual university to a second one in order to earn a degree or training in a specific branch of knowledge. This situation is frequent in Cameroon and has many causes. The first cause is linked to students who live with their parents, if these parents are civil servants and are sent in another region, the student needs to move with them to continue his training. Another situation is when new universities are created in other regions. The region may be the native region of a student in which the cost of the live is better. The concerned student can prefer move to the new university. A third situation is linked to pandemics such as COVID-19, that according to authors in [1], has transformed the social and economic situations of many people, with serious implications for their physical and mental health, as well as complicating aspects of life previously taken for granted. For a country like China who is currently the largest exporting country of international students in the world [2] and the largest receiving country of international students in Asia [3]. Its international student mobility has been seriously affected [4].

However, university don't have the same student circuit and when a student have to move from a university to another, the problem is how can we conserve his marks and calculate his level. According to [5], there are two dominant kinds of student mobility, (i) *Horizontal mobility*: Students move from a home university to a host university for a short period of time, typically one semester or an academic year. During this time, students take courses at the host university that are later on recognized at their home university as part of their curriculum to get their degree. Mobility arising from double degrees belongs to this category. (ii) *Vertical mobility*: Students finish a degree in one university (with or without a horizontal mobility period) and they move to a different university to continue with their studies at the next level. This is the case when a student gets a

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bachelor degree from one university and moves to a different university to take his/her master degree.

The vertical mobility is also called **degree mobility**. It is defined as the physical crossing of an academic border to enrol in a degree programme at tertiary level in the university of destination [6]. The horizontal mobility is also called **credit mobility**. It is defined as temporary tertiary education and/or study-related traineeship in another university within the framework of enrolment in a tertiary education programme at a 'home institution' (usually) for the purpose of gaining academic credit (i.e. credit that will be recognised by that home institution) [6].

The student mobility management states a problem of variability. For this phenomenon modeling, the Feature Oriented Domain Analysis (FODA) has been proposed [7]. FODA is a well known Domain Engineering method for modeling variability developed at the Software Engineering Institute of Carnegie Mellon University. This method is often used to express requirements on different possible configurations of a discussed concept and consist of three necessary activities:

- Context Analysis for which the purpose is to define the scope of a domain that is likely to yield exploitable domain products;
- Domain Modeling activity for which the goal is to analyze commonalities and differences of the problems that are addressed by the applications in the domain;
- Architecture Modeling, which aims to provide a software solution to the problems defined in the domain modeling phase.

FODA architecture is a high level design, that why authors of FODA extended their method in the Feature Oriented Reuse Method with Domain-Specific Reference Architecture (FORM) [8] to the software design phase and prescribes how the feature model introduced in FODA is used to develop domain architectures and components for reuse. Considering the fact that FORM is semi-formal (for example, the concept of feature is devoid of formal structure) and was applied mainly to industrial domains, for information system concerns, we have enrich feature models by describing and inserting them in an envelope, giving a structure to features, that is what we called business component semantics. The Feature Oriented Reuse Method with Business Component Semantics (FORM/BCS) [9, 10, 11, 12, 13, 14, 15] is the name we gave to the new approach which is a software product line engineering method. With the new structure given to features and feature models of FORM/BCS, rigorous analysis can be done and based on this background; we defend that we can highlight the problem of variability in student mobility. Our main question is: how can we create a model that allows to (1) automatically defining the study level of a student once he gets an enrolment in a new university, (2) transferring credit from the student home university to the host one? This article tackles this question.

The rest of the paper is structured as follows. Section 2 reviews current approaches for student mobility management. Section 3 exposes our proposal which is a model to manage student mobility in Cameroon university ecosystem. A case study is presented in Section 4 to show the application of the proposed model in a Cameroonian university and section 5 closes the article and gives perspectives.

2. Related Works

Different programs initiates by European Union to encourage international mobility amid higher education students had been presented by author in [5]. These programs comprise intra-European mobility and also student exchanges with countries out of Europe. Here we briefly remind a few of them:

- The EuRopean community Action Scheme for Mobility of University Students (ERASMUS) program was only for intra-European mobility.

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- The Trans-European Mobility Program for University Students (TEMPUS) is the European Union's program which supports the modernization of higher education in the Partner Countries of Eastern Europe, Central Asia, the Western Balkans and the Mediterranean region, mainly through university cooperation projects.
- The Erasmus Mundus program aimed to enhance the quality of higher education and promote dialogue and understanding between people and cultures through mobility and academic cooperation.
- The Erasmus+ program pursues objectives of previous programs, and furthermore, has to increase the qualifications and employability for young people and to renovate the education, training and work opportunities.

The Erasmus program has been exceedingly successful and it is now a model for programs. This is supported by two realities. First, the big numbers of students that have spent a period of time studying abroad. Second, studies [16, 17] have shown that former Erasmus students find an employment more easily than the ones that take the entire degree program at their home university.

The Bologna Process, in the strict sense speaking, is not a mobility project. His main objective is to make easy the movement from one European country to another to workers holding a university degree.

Tools that help to develop student mobility programs in each university exist such as Networking, the European Credit Transfer System and Quality assessment, but it is not possible to just plug and play these tools. Applying them needs to consider the university area in which you are and consequently to customize them.

Similar initiatives in terms of student mobility programs are implemented in Central Africa in the Economic and Monetary Community of Central Africa (CEMAC) zone where all countries have to adopt the BMP (Bachelor, Master, Doctorate / PhD) academic organization. In addition, mobility is favored by the equality of students in terms of payment of university fees. Indeed, in the CEMAC zone, each student pays the same amount of university fees whether they are in their home country or not. The regulation in force in the CEMAC zone sets the amount of university fees at 50,000 CFA francs for all students from the sub-region. These programs are relevant in terms of research to the extent that they promote the exchange of experiences and make it possible to avoid the human compartmentalization of laboratories and to involve students from diverse backgrounds to propose possible solutions to their concerns. Concerning socio-professional integration, student mobility programs are also very important since for talented students who are able to easily acquire knowledge, skills and attitudes, they will less and less face glaring employability challenges in their home country. However, to be able to benefit from the profits linked to student mobility programs, universities must submit to constraints or requirements that make these tools not easily applicable [18, 19]. They are listed in the table 1, in which we give for each constraint or requirement the cause of this situation and the attempts at improvement.

Table 1. Constraints and requirements of student mobility programs

Constraints/Requirements	Reasons	Improvements track
Underfunding of education and research	The weakness of the economy	- Improving the economy; - Implementation of the university-business concept
The lack of infrastructure	A significant proportion of teaching is done face-to-face	Perform teaching in hybrid mode (face-to-face and distance learning)
The lack of qualified personnel	Low strengthening of staff capacities	Implementation of ongoing training of staff
The lack of qualification of university teachers	University teachers are much more valued in terms of research	Revise the recruitment and evaluation processes for university teachers by placing place a real emphasis on teaching and

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		development support and not much more on research
The low rate of professional integration of graduates	Mismatch between training proposed and the real needs of the labor market	Professionalization of teaching and entrepreneurship
The heterogeneity of study regimes which differ from one country to another and even from one university to another in the same country	Not all universities belong to the same ecosystem and pursue objectives that are not always the same.	Harmonization as much as possible of study regimes through a management model accepted by the various stakeholders

3. Method

3.1 Research description

In the higher education ecosystem in Cameroon, we observe disparities that do not favor student mobility. We clarify a sample of these facts in the following lines.

- The understanding of the current academic organization is not the same for all stakeholders. There are differences in the understanding of concepts. For example, the notion of establishment differs from one university to another. It is equivalent to a domain in certain universities and to a set of domains in others; the concept of department differs from one university to another. It corresponds to a mention (or discipline) in certain universities and to a set of disciplines in others. The notion of teaching unit does not have the same semantics in all universities. It is a set of constituent elements for certain universities while for others it is contained in a group (or module) of teaching units. These differences have an influence on the quality of teaching;
- Student management follows rules which differ from one university to another and sometimes even from one school or faculty to another in the same university. For some universities, a teaching unit is a set of constituent elements and for the same teaching unit, constituent elements complement each other while in others universities, constituent elements of the same teaching unit does not. In certain universities, if a student obtains a mark less than 07/20 in a constituent element, he can't take the credit for the teaching unit of this constituent element. For others universities, teaching units are brought together in groups (or modules) of two or three teaching units.

This situation means that if we want to manage the mobility of students in that ecosystem, we must first model this variability and try to establish correspondences between the different management rules. Having a model that captures formally, that is in a rigorous language like Z Notation, this variability and proposing a framework, that means a set of steps, to manage student mobility by implementing this model is our concern in this research. The proposal in that stage is not a program code but a model and a framework in a rigorous language.

This article, which is the first in this research, focuses mainly on the functional aspects. The model we propose allows for example, to determine the courses that a student coming from a home university must take in the host university. For that, it is essential to establish equivalences between the courses of the host university and those of home university; courses at the host university which have no equivalence in the courses at the home university that the student has completed must be followed and validated at the host university. Non-functional aspects such as the accuracy and integrity of data transferred from the student home university to the host one, speed required to complete the credit transfer process and navigation between universities are very important concerns which will be the subject of further articles.

For example, regarding the concern about the accuracy and integrity of data transferred from the student's home university to the host university, a non-functional concern, we are considering implementing uses blockchain technology. In its formal definition, blockchain is a distributed and

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decentralized ledger which allows information to be stored and exchanged without trust levels. This register serves as a history of all actions carried out by participants (called nodes) since its creation. Confidentiality, security, anonymity, decentralization and transparency are particular characteristics of the blockchain technology which make it unique to users from different domains.

3.2 Student mobility in Cameroon university ecosystem managing model

The Cameroon university ecosystem is the BMP (Bachelor, Master, Doctorate / PhD) system, which designates an academic organization in three cycles leading to the degrees of Bachelor, Master and Doctorate / PhD.

- The License Cycle Leads To The Degree Of License;
- The Master's Cycle Leads To The Master's Degree;
- The Doctoral Cycle Leads To The Degree Of Doctorate/Phd

The General Objectives Pursued By The BMP System Are The Following:

- Promote Professionalization In Order To Reduce Unemployment Among Graduates;
- Align Cameroon's Higher Education System With International Standards;
- Ensure Learner Autonomy In Learning Processes.

The Specific Objectives Pursued By The BMP System Are:

- Ensure For All The Parties Concerned, A Better Readability Of The Degrees, Graduates, Training And Levels Of Professional Integration;
- Produce Versatile Diplomas, Endowed With Knowledge And Skills Likely To Guarantee Their Social And Professional Integration;
- Set Up A Training System Characterized By Flexibility And International Comparability;
- Reform And Diversify The Training Paths So As To Offer The Student, Everyone The Levels Of Opportunities For Adaptation To The Contemporary World;
- Promote Student Mobility On A National, Sub-Regional And International Scale;
- Facilitate The Equivalence Of Diplomas;
- Encourage The Learning Of Transversal Skills;
- Develop Innovative Teaching Methods;
- Promote Entrepreneurship.

The training architecture is founded in three cycles: the bachelor cycle leading to bachelor degree, the master cycle leading to master degree and the doctorate/PhD cycle leading to doctorate/PhD degree. The training offered by the BMP system states his domains, disciplines, curricula and specialties. The BMP domains are groups of mentions or disciplines in a large and coherent set. Each discipline states his specialties. A curriculum (or specialty) is a coherent set of Teaching Units or courses. A Teaching Unit is a set of Constituent Elements. This section gives the FORM/BCS semantics of the BMP study plan. The Z formal specification language [20, 21] is used because it lays down the foundation for a rigorous analysis of the method assets and the UML modeling concepts specified by OMG [22] because they are able to support domain engineering. We will use principally the UML types Attribute, Operation, Action and universal types like Boolean and Text which will be considered as basic. BMP study plans are modeled as follows:

BMPStudyPlan = = [name: **TEXT**;
description: **Description**
body: **Body** |]

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BMP study plan descriptions: These parts of a study plan provide its intention, which is the set of academic activities the descriptor aims to specify; its target, which is the concerned training and research units; and the environment that is the set of study cycles. Each training and research unit states its domains, disciplines and specialties. For a better understanding, we consider training and research units and departments as administrative units while domains, disciplines and specialties are academic units. The following Z notation schema details study plan descriptions.

Specification of Study Government Descriptions

Description == [intention: 𝔽**AcademicActivity**;
target: 𝔽 **TrainingAndResearchUnit;**
degrees: 𝔽 **BMPDegree** |]
AcademicActivity == {teaching, research, development ...}
TrainingAndResearchUnit == [name: **TEXT**;
domains: 𝔽 **Domain** |]
Domain == [name: **TEXT**;
departments: 𝔽 **Department** |]
Department == [name: **TEXT**;
disciplines: 𝔽 **Discipline** |]
Discipline == [name: TEXT;
domain: Domain
specialities: 𝔽 Speciality |]

Specialties

A specialty is a named business. Institutions of higher education create bridges between specialties to facilitate, if necessary, the mobility of students within a same establishment or between different establishments; The Z notation schema below specifies specialties.

Specialty ==[name: **TEXT**;
discipline: **Discipline**
specialities: ▯ **Speciality** |]

BMP degrees

A prepared degree of a description gives basic diplomas, the set of delivered diplomas, the minimal number of semesters, the maximal number of semesters and the minimal number of credits. The following Z notation schema details description prepared degrees.

BMPDegree == [name: **TEXT**;
basicdiplomas: 𝔽 **Diploma;**
delivereddiplomas**:** 𝔽 **Diploma;**
numberofsemester**: INTEGER;**
minimalnumberofsemester**: INTEGER;**
maximalnumberofsemester**: INTEGER;**
numberofcredits: **INTEGER**
minimalnumberofcredits: **INTEGER** |
∀d : BMPDegree, minimalnumberofsemesters(d)≤numberofsemesters(d)
≤maximalnumberofsemester(d)
∀d : BMPDegree, minimalnumberofcredits(d)≤numberofcredits(d)]

Diploma = **TEXT**

BMP study plan bodies: To define study plan bodies, we precise first FORM/BCS semantics of the following concepts: "constituent element", "teaching form" and "teaching unit". These concepts are used in the study plan body's model.

Constituent Elements

They are characterized by a name and the number of credits. The Z notation schema below captures them.

ConstituentElement == [name: **TEXT**;
creditsnumber: **INTEGER** |]

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Teaching Forms

A teaching unit can be constituted with many teaching forms: lectures, tutorials, practices, student's personal work (SPW), internships and end of studies' projects. The following Z notation schema captures teaching forms.

TeachingForm = = Lecture | Tutorial | Practice | SPW | Internship | Project

Teaching Units

A Teaching Unit is a named set of Constituent Elements. The following Z notation schema describes teaching units.

TeachingUnit == [name: **TEXT**;
creditsnumber: **INTEGER**;
components: $\mathbb{F}$ **ConstituentElement**
teachingforms: $\mathbb{F}$ **TeachingForm** |
$\forall$ *tu: TeachingUnit, creditsnumber(tu)* $= \sum_{ce \in components(tu)} creditsnumber(ce)$]

The body of a study plan is a set of training realizations. A training realization is a training cursus which is a set of semesters corresponding to a specialty. The Z notation schema below describes study plan bodies.

Specification of Study Government Bodies

Body == [realizations: $\mathbb{F}$ **TrainingCursus** |]

TrainigCursus = = [name: **Specialty**;
prepareddegree: **BMPDegree**
semesters: $\mathbb{F}$ **Semester** |]

Semester = = [numberorder: **INTERGER**;
weeksnumber: **INTEGER;**
creditsnumber: **INTEGER;**
teachingunits: [mandatory: $\mathbb{F}$ **TeachingUnit;**
optional: $\mathbb{F}$ **TeachingUnit;**
free: $\mathbb{F}$ **TeachingUnit** |] |
$\forall$ *s : Semester, teachingunits(s) = mandatory(teachingunits(s))* $\cup$
optional(teachingunits(s)) $\cup$
free(teachingunits(s))
$\forall$ *s : Semester, creditsnumber(s)* $= \sum_{tu \in teachingunits(s)} creditsnumber(tu)$]

Evaluation metrics: For the assessment of the method's success and areas for improvement, we introduce specific evaluation metrics or criteria as follows:

- The degree of specialization of establishments which is equal to the number of areas in which the establishment provides teaching. The higher the degree of specialization, the less specialized the establishment.
- The degree of specialization of departments which is equal to the number of disciplines in which the department provides teaching. The higher the degree of specialization, the less specialized the department.
- The coverage of a domain that is equal to the number of disciplines covered in the domain. The higher this number, the more the area is covered.
- The coverage of a discipline that is equal to the number of specialties considered in the discipline. The higher this number, the more the discipline is covered.
- The density of a specialty which is equal to the number of teaching units contained in the specialty. The higher this number, the denser the specialty
- The density of a teaching unit which is equal to the number of constituent elements contained in the teaching unit. The higher this number, the denser the teaching unit

The proposed model allows, given a system study plan, to have the above evaluation metrics.

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3.3 Students mobility

The model specified in this work aims the management of student mobility. To doing this, each student has a corresponding instantiation of a training cursus and a national registration number which allows managing him. In the beginning of his training, he can have a speciality or not. Each student prepares a degree and is characterised by a set of applied semesters. For a student, an applied semester is a semester in his training cursus for which he has already fixed his optional and free teaching units. When a student chooses an optional teaching unit, this one is managed as a mandatory teaching unit for him but he has the possibility to replace an optional teaching unit by another. The following Z notation schema allows modeling students.

```
Student = = [registrationnumber: TEXT;
             institution: BMPStudyPlan
             establishment:TrainingAndResearchUnit
             department: Department
             trainingcursus: TrainingCursus | ]
```

Basic functions: To manage student mobility, we define followings basic functions

a. *Specialty* which, given a student provides his specialty;
b. *Institution*which, given a specialty returns the BMP study plan in which this specialty is teaching;
c. *Transferable_speciality* which, given a student and a specialty returns true or false if this student is transferable to this specialty or not;
d. *Transferableestablishment* which, given a student and an establishment (that is a training and research unit) returns true or false if this student is transferable to this establishment or not.

```
specialty: Student ↔ Specialty
    ∀ st: Student, sp: Specialty, specialty (st) = sp ⇔ sp = name(trainingcursus(st))

institution: Specialty ↔ BMPStudyPlan
    ∀ sp: Specialty, pl: BMPStudyPlan, institution (sp) = pl ⇔
    domain(discipline(sp)) ∈ domains(T ∈ target(description(pl)))

transferable_specialty: Student x Specialty ↔ Boolean
    ∀ st: Student, sp: Specialty, transferable_specialty(st,sp) = true ⇔
    (name(institution(st)) = name(institution(sp)) ∧
                            sp ∈ bridges(specialty(st)))

transferable_establishment: Student x TrainingAndResearchUnit ↔ Boolean
      ∀ st: Student, tru: TrainingAndResearchUnit,
      transferable_establishment (st, tru) = true ⇔
      (name (establishment(st)) = name(tru) ∧
      specialty(st) ∈ specialties(di ∈ disciplines(de ∈ departments(do ∈ domains(tru)))))
```

Mobility mechanism: For student mobility, we have to record his credits so that we can determine his level and transfer his credits from his home university to the host one. To permit these operations, we define following schemas for student performances in teaching units and constituent elements.

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StudentPerformance = 𝔽 **PerformanceInTeachingUnit**

PerformanceInTeachingUnit = = [student: **Student**
teachingunit: **TeachingUnit**
capitalized: **BOOLEAN**
details: 𝔽 **PerformanceInConstituentElement**
numberofcredits: **INTEGER** |]

PerformanceInConstituentElement = = [student: **Student**
Constituentelement: **ConstituentElement**
capitilized: **BOOLEAN**
mark: **INTEGER** |]

To transfer credit obtained by a student in a teaching unit from the home university to the host one, we must determine the equivalent teaching unit in the host university. To this end, we define the following function *equivalence* for which given a teaching unit in the origin university and the destination university, determines the equivalent teaching unit in the host university.

equivalence: TeachingUnit x BMPStudyPlan ↔ TeachingUnit
∀ tu1, tu2: TeachingUnit, sp: BMPStudyPlan,
equivalence(tu1, sp) = tu2 ⇔ tu1.name = tu2.name

The following algorithm, named TRANSFER-CREDITS, which takes three parameters that we separate by commas in the specification, is defined for the transfer of credits in student mobility management. In the algorithm below, comments in one line are preceded by the notation "//" and for comments in multiple lines we start by the notation "/*" and end with the notation "*/".

Algorithm: TRANSFER-CREDITS(*hostsp*, *stu*, *homestp*)

Inputs:
// The variable *hostsp* contains the study plan in the host university
- *hostsp*: BMPStudyPlan

// The variable *stu* contains the student mobility candidate
- *stu*: Student

// The variable *homestp* contains the student performance in the home university
- *homestp*: StudentPerformance ;

Output:
// The variable *hoststp* contains the student performance in the host university
- *hoststp*: StudentPerformance

Intermediate variables:
/* Variables *pitu1* and *pitu2* contain the student performance in the home and the host university respectively */
- *pitu1*, *pitu2*: PerformanceInTeachingUnit;

1. *hoststp* := Ø
2. **For each** *pitu1* **in** *homestp*
   A. *pitu2.teachingunit* := equivalence(*pitu1.teachingunit*, *hostsp*)
   B. **If** *pitu1.capitalized* = **TRUE then**
      pitu2.capitalized := **TRUE**
   else
      pitu2.capitalized := **FALSE**
   end
   C. *hoststp* := *hoststp* ∪ {*pitu2*}

end

4. Results and Discussion

4.1 An Application Case Study: The University of Yaounde I BMP system

An implementation of the defined management model is given below. We take the example of a State university in Cameroon, the University of Yaounde I, and give below a sketch of the Bachelor, Mater and PhD system study plan in that Institution:

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Nom *: The University of Yaounde I BMP study plan*

Description *:*

Intention *: {teaching, research, development}*

Target *:*

Establishments :

TRU1 = [name = Higher Teacher Training College;

Domains:

DO1 = [name = Sciences

departments:

DE1 = [name = Computer Science and Educational Technologies

disciplines:

DI1 = [name = Fundamental ComputerScience

specialties:

SP1 = [name = Software Engineering

bridges:

BR1 = [name = Information systems

Bridges:…

BR2 = [name = Multimedia systems

Bridges:…

SP2 = [name = Information systems

bridges:

BR1 = [name = Software Engineering

Bridges:…

BR2 = [name = Multimedia systems

Bridges:…

SP3 = [name = Multimedia systems

bridges:

BR1 = [name = Software Engineering

Bridges:…

BR2 = [name = Information systems

Bridges:…

DI2 = [name = Information and Communication Technologies

specialties:

SP1 = [name = EducationalTechnologies

bridges:

BR1 = [name = Pedagogy

Bridges:…

BR2 = [name = Didactic

Bridges:…

SP2 = [name = Pedagogy

bridges:

BR1 = [name = EducationalTechnologies

Bridges:…

BR2 = [name = Didactic

Bridges:…

SP3 = [name = Didactic

bridges:

BR1 = [name = EducationalTechnologies

Bridges:…

BR2 = [name = Pedagogy

Bridges:…

DE2 = [name = Mathematics and Physical Sciences

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disciplines:
DI1 = [name = Mathematics
specialties:
SP1 = [name = Algebra
bridges:
BR1 = [name = Analysis
Bridges:...
BR2 = [name = Geometry
Bridges:...
SP2 = [name = Analysis
bridges:
BR1 = [name = Algebra
Bridges:...
BR2 = [name = Geometry
Bridges:...
SP3 = [name = Geometry
bridges:
BR1 = [name = Analysis
Bridges:...
BR2 = [name = Algebra
Bridges:...

***degrees**:*
DEG1 = [name = Bachelor
Basicdiplomas = {Baccalaureat, General Certificate of Education Advanced Level}
delivereddiplomas: {Licence, Bachelor}
numberofsemester = 6/7/8
minimalnumberofsemester = 6
maximalnumberofsemester = 8
numberofcredits = 180
minimalnumberofcredits = 180
]
DEG2 = [name = Master
Basicdiplomas = { Licence, Bachelor}
delivereddiplomas: {Master}
numberofsemester = 4/5/6
minimalnumberofsemester = 4
maximalnumberofsemester = 6
numberofcredits = 120
minimalnumberofcredits = 120
]
DEG3 = [name = PhD
Basicdiplomas = {Master}
delivereddiplomas: {PhD}
numberofsemester = 6/7/8/9/10
minimalnumberofsemester = 6
maximalnumberofsemester = 10
numberofcredits = 180
minimalnumberofcredits = 180
]

DO2 = [name = Letters...

Body :
realizations:
Cursus:
CU1 = [name = Software Engineering
BMPdegree = DEG1
semesters:

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```
            SE1 = [ numberorder: 1;
                        weeksnumber: 14;
                        creditsnumber: 30;
                        teachingunits:
                        [mandatory: {Teaching Unit 1, Teaching Unit 2, ...}
                                optional: {Teaching Unit 1, Teaching Unit 2,
                                ...}            free: {Teaching Unit 1,
                                Teaching Unit 2, ...}
                                ]
            ]
            SE2 = [ numberorder: 2;
                        weeksnumber: 14;
                        creditsnumber: 30;
            teachingunits:
                        [mandatory: {Teaching Unit 1, Teaching Unit 2, ...}
                                optional: {Teaching Unit 1, Teaching Unit 2,
                                ...}            free: {Teaching Unit 1,
                                Teaching Unit 2, ...}
                                ]
            ]
            ...
]

CU2 = [name = Information Systems
BMPdegree = DEG1
semesters:
            SE1 = [ numberorder: 1;
                        weeksnumber: 14;
                        creditsnumber: 30;
                        teachingunits:
                        [mandatory: {Teaching Unit 1, Teaching Unit 2, ...}
                                optional: {Teaching Unit 1, Teaching Unit 2,
                                ...}            free: {Teaching Unit 1,
                                Teaching Unit 2, ...}
                                ]
            ]
            SE2 = [ numberorder: 2;
                        weeksnumber: 14;
                        creditsnumber: 30;
            teachingunits:
                        [mandatory: {Teaching Unit 1, Teaching Unit 2, ...}
                                optional: {Teaching Unit 1, Teaching Unit 2,
                                ...}            free: {Teaching Unit 1,
                                Teaching Unit 2, ...}
                                ]
            ]
            ...
]
...
```

The provided code outlines the structural components of a university study program at the University of Yaounde I. It is organized into several key sections: **Intention:** The intention of the program is articulated, emphasizing the goals of teaching, research, and development. This sets the broader context for the study plan. **Target Establishments:** The target establishment, TRU1, is identified as the Higher Teacher Training College. This indicates where the program is intended to be implemented. **Domains:** Two domains, DO1 and DO2, are specified. DO1 is dedicated to "Sciences," while DO2 encompasses " Letters." This categorization helps define the overarching

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fields of study within the program. **Departments:** Two departments, DE1 and DE2, are outlined. DE1 focuses on "Computer Science and Educational Technologies," while DE2 centers on "Mathematics and Physical Sciences." Departments represent broader academic units within the program. **Disciplines:** Disciplines are specified under each department. For example, DE1 includes "Fundamental Computer Science," and DE2 includes "Mathematics." Disciplines denote specific areas of study within a department. **Specialties:** Specialties are detailed under each discipline. Examples include "Software Engineering" under "Fundamental Computer Science" and "Algebra" under "Mathematics." Specialties represent more focused areas of expertise within a discipline. **Bridges:** Bridges between specialties are defined, such as BR1 and BR2 under each specialty. These bridges likely signify connections or overlaps between different areas of specialization. **Degrees:** Three degrees, DEG1 (Bachelor), DEG2 (Master), and DEG3 (PhD), are specified. This section provides essential information about the basic and delivered diplomas, the number of semesters, maximal and minimal durations, as well as credit requirements for each degree level. **Realizations:** This section describes the realization of the study plan, introducing different courses (Cursus) like CU1 (Software Engineering) and CU2 (Information Systems). It also associates each course with a specific degree (BMPdegree). **Semesters:** Semesters within each course are outlined (e.g., SE1 and SE2). Details include the number order, weeks number, credits number, and categorization of teaching units into mandatory, optional, and free units. This provides a granular breakdown of the curriculum structure.

In summary, this code serves mainly as a comprehensive blueprint for the organization of a computer science program, covering various academic levels, disciplines, and specializations, along with the associated degree requirements and course structures.

4.2 Comparative analysis of approaches

In student mobility, we have several approaches. In [23], the author mentioned four approaches:

- The **Mutual Understanding** approach for which the motivation is to foster relationships between institutions;
- The **Skilled Migration** approach whose intention is to attract talented students;
- The **Revenue-Generating** approach which aims to promote the higher education system of the host institution;
- The **Capacity Building** approach whose intention is to build capacity for quality in a quick way, and to meet the unmet demand of higher education.

Each approach has a specific advantage which is to promote cooperation for the mutual understanding approach, to allow someone have an elite in the diaspora for the skilled migration approach, to increase the reputation of the institution for the Revenue-Generating approach and to respond punctually to a need for the capacity-building approach. For these four approaches, the common disadvantage is that, the entire education system is not concerned. To better understand the FORM/BCS approach that we propose, we perform a comparative analysis of approaches of student mobility in table 1.

Table 2. Advantages and disadvantages of student mobility approaches

Approach	Motivation	Advantage	Disadvantage
The mutual understanding	Foster relationships between institutions	Promote cooperation	The entire education system is not concerned
The skilled migration	Attract talented students	Allows you to have an elite in the diaspora	The entire education system is not concerned
The Revenue-Generating	Promotion of the host institution's higher education system	Increase the reputation of the institution	The entire education system is not concerned

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The Capacity Building	Build capacity for quality in a quick way, and to meet the unmet demand of higher education	Respond punctually to a need	The entire education system is not concerned
FORM/BCS Approach	Reduce the upgrade and adaptation period for student	The entire education system is concerned	A great harmonization work must happen upstream

4.2 Conditions for student mobility management

For the management of student mobility, the case study presented in 4.1 reveals that it is essential to have details of the entire up to date academic organization of all institutions involved in that mobility for it to be managed. This requirement is justified by many reasons:

- Study programs of all institutions are not harmonized such that all stakeholders agree on the courses that students should follow;
- All institutions don't have a same understanding of concepts: for example, in certain institutions, a teaching unit is divided into a group of constituent elements which complement each other within the same teaching unit; in others institutions, teaching units are grouped and complement each other within the group;
- The balance between theory and practice in a teaching unit is not the same;
- The teaching college which provides a study program is not the same in the different institutions.

In this regard, we formulate the following recommendations for future research and practical enhancements which will require the involvement of experts in writing educational programs upstream and their integration into the system:

Recommendation 1: For all stakeholders to have a same language, a same nomenclature of concepts must be defined;

Recommendation 2: For the agreement of all stakeholders in the management of student mobility, it is very important to harmonized study programs of all institutions;

Recommendation 3: When defining study programs, details on the balance between theory and practice should be clarified to ensure correspondences between teaching units;

Recommendation 4: For good academic mobility, it is important to define the profiles of the teachers who will be involved in the training and to respect theses profiles.

5. Conclusion

In this work, we raise two kinds of student mobility: the *Horizontal mobility* which happens when a student change position from an origin university to a destination university for a short period of time, generally one semester or an academic year, and the *Vertical mobility* which happens when students complete a degree in one university (with or without a horizontal mobility period) and they move to a dissimilar university to continue with their studies at the next level. For this phenomenon of mobility student have many difficulties such as how their credit can be transfer from the home university to the host one. The goal of this work was to suggest a management model for student mobility permitting once a student gets an enrolment in a new university to transfer his credits from the home university to the host one. Non-functional aspects such as the accuracy and integrity of data transferred from the student home university to the host one, speed required to complete the credit transfer process and navigation between universities are very important concerns which will be the subject of further works.

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References

[1] D. Cairns, T. França, "Managing Student Mobility during the COVID-19 Pandemic: An Immobility Turn in Internationalized Learning?" Societies 2022, 12, 105. doi: 10.3390/soc12040105.

[2] Y. Yue, "The determinants of international students inward mobility to China," Journal of National Academy of Education Administration, 20(08), 71-77, 2013.

[3] W. Ha, D. Y. Chen, "Talent mobility and education dividend - A research review on the education of international students in China," Education Research Monthly, 36(03), 55-64, 2019.

[4] Q. Yang, J. Shen, "The Impact of COVID-19 Outbreak on International Student Mobility: Analysis, Response Strategies and Experience from China," Journal of Comparative & International Higher Education, Volume 14, Issue 1, pp. 132-149, 2022.

[5] F. Cornet, "Student Mobility in European Higher Education," J. Higher Education and Lifelong Learning, vol. 22, 2015.

[6] M. S. Barrioluengo, S. Flisi, "Student mobility in tertiary education: institutional factors and regional attractiveness," Publications Office of the European Union, Luxembourg, 2017, EUR 28867 EN. ISBN 978-92-79-76295-6. doi:10.2760/675338. JRC108895.

[7] James A. Hess William E. Novak Kyo C. Kang, Sholom G. Cohen and A. Spencer Peterson. 1990. Feature-oriented domain analysis (FODA) feasibility study. Technical Report CMU/SEI-90-TR-21. Carnegie-Mellon University, Pennsylvania , USA.

[8] K. C. Kang, S. Kim, E. Shin, and M. Huh, "FORM: A Feature-Oriented Reuse Method with Domain-Specific Reference Architectures," Annals of Software Engineering, Vol. 5, pp. 143-168, 1998.

[9] M. Fouda, Amougou Ngoumou, "The Feature Oriented Reuse Method with Business Component Semantics", International Journal of Computer Science and Applications, Vol. 6, No. 4, 2009, pp 63-83.

[10] N. Amougou, M. Fouda,, "A Rewriting System Based Operational Semantics for the Feature Oriented Reuse Method ", International Journal of Software Engineering and Its Applications, Vol.7, No.6, pp.41-60, 2013.

[11] N. Amougou, M. Fouda, "A Command Oriented Derivation Approach with Product-Specific Architecture Optimization", International Journal of Software Engineering and Its Applications, Vol. 9, No. 2, pp. 23-40, 2015. doi:10.14257/ijseia.2015.9.2.03

[12] N. Amougou, M. Fouda, , "Feature-Relationship Models: A Paradigm for Cross-hierarchy Business Constraints in SPL", International Journal of Computer Science and Information Security, Vol. 16, No. 9, pp. 112-124, 2018.

[13] N. Amougou, M. Fouda, , " Dynamic software product lines development platform's architectures: A feature business components driven approach ", International Journal of Computer Science and Information Security, Vol. 17, No. 11, pp. 81-93, 2019.

[14] N. Amougou, M. Fouda, , "Context metamodel in pervasive systems for dynamic software product lines", Journal of Software Engineering & Intelligent Systems, Volume 5, Issue 3, pp. 124-137, December 2020.

[15] N. Amougou, M. Fouda, , "Extended dynamic software product lines architectures for context integration and management", Journal of Software Engineering & Intelligent Systems, Volume 6, Issue 1, pp. 28-41, April 2021.

[16] L. Dolga, H. Filipescu, M. M. Popescu-Mitroi, C. A. Mazilescu, "Erasmus Mobility Impact On Professional Training And Personal Development Of Students Beneficiaries," 6th World Conference on Educational Sciences, Elsevier, 2015.

[17] F. Mizikaci, Z. U. Arslan, "A European Perspective in Academic Mobility: A Case of Erasmus Program," Journal of International Students, Volume 9, Issue 2, pp. 705-726, 2019, doi 10.32674/jis.v9i2.1138

[18] Campus France, "Mobilité et coopération universitiare en Afrique subsaharienne," Dynamique Régionale, No.1, December 2019.

[19] Campus France, "Les grande tendances de la mobilité étudiante en Afrique subsaharienne," Dynamique Régionale, No.4, November 2022.

[20] S. H. Bakri, H. Harun, A. Alzoubi, R. Ibrahim, "The Formal Specification for the Inventory System Using Z Language," Proceedings of the 4th International Conference on Computing and Informatics, ICOCI 2013, 28-30 August, No 064, pp. 419-425, 2013 Sarawak, Malaysia.

[21] A. F. Al Azzawi, M. Bettaz, H. M. Al-Refai, "Generating Python Code from Object-Z Specifications," International Journal of Software Engineering & Applications (IJSEA), Vol.8, No.4, July 2017.

[22] OMG, "Unified Modeling Language (UML)", version 2.5.1, N°formal/2017-12-05, Décembre 2017.

[23] I. N. Reczkowski, "International Student Mobility, Student Exchange Programs, and Migration: Evidence from Gravity Estimations," Dissertation to obtain the doctoral degree of Economic Sciences, Faculty of Business, Economics and Social Sciences, University of Hohenheim, 2022.

http://dx.doi.org/10.36596/jcse.v4i2.720