Cross-fertilization between three different teaching modes for geo-informatics education

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SUMMARY

Objective of this study was to determine if the use and student appreciation of course materials differs for native materials (materials that were developed for that course type in which they are used) and foreign materials (materials that were developed for another course type) and if the way the materials are used, (compulsory versus optional, interchangeable versus the only source of information) affects the student appreciation.
A comparison was made between a face-to-face course, a blended learning course and a distance course. The comparison was based on a questionnaire, the course evaluation and the statistics from the digital learning environments. Results show no difference between native and foreign course materials, but do however show the influence of the way the materials were used. Appreciation for compulsory, non-interchangeable materials is higher than for optional interchangeable ones, but even for this last category the general appreciation is high. Distance students have the highest overall appreciation for study materials, followed by the face-to-face students.

SAMENVATTING

Doelstelling van deze studie was om te onderzoeken of de waardering van studenten voor onderwijsmateriaal wordt beïnvloed door het feit dat het materiaal al dan niet voor dit type onderwijs ontwikkeld werd, en wat het effect is van de manier waarop het materiaal wordt gebruikt (verplicht versus optioneel, vervangbaar of de enige bron van informatie).
Een vergelijking werd uitgevoerd tussen een contact onderwijs module, een afstandsonderwijs module en een module waar het zogenaamde “blended learning” werd toegepast. De vergelijking werd uitgevoerd middels een enquête, de student evaluaties en statistische gegevens uit de digitale leeromgeving. Resultaten laten geen verschil zien tussen materialen die voor de cursus ontwikkeld zijn en materialen die oorspronkelijk uit een andere cursus afkomstig waren, maar laten wel verschil zien tussen materiaal dat als optioneel wordt aangeboden tegenover verplichte leerstof en materiaal dat op meerdere manieren wordt aangeboden. Student waardering voor verplichte, onvervangbare materialen was hoger dan voor optioneel en vervangbaar onderwijsmateriaal, maar zelfs voor optioneel vervangbaar materiaal was de student waardering relatief hoog. In het algemeen is de waardering voor het materiaal het hoogste onder afstandsonderwijs studenten gevolgd door contact onderwijs studenten.

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1. BACKGROUND

Over the past decade many educational institutes developed e-learning courses based on their regular face-to-face education. In many cases, this was done via international projects (especially European) with a lot of attention turned to sharing materials and exchange of development experience between these international educational institutes (Purves et al 2004). Less attention was paid to sharing teaching materials between courses with the same content but different teaching modes within one institute. This paper looks at how and to what extent cross fertilization took place between three courses in "Principles of Geo-informatics" at the International Institute for Geo-information Science and Earth Observation (ITC).

There are important differences between sharing materials between educational institutes and sharing between courses within the same institute. Sharing between institutes is often referred to as "interoperability". Interoperability aims to allow sharing of data and materials through the use of common agreements and specifications (Pruves et al 2005). In a general sense the concept was defined by Kemp et al. (1999) as the creation of materials which are shareable and can have multiple uses in various contexts. Sharing the materials is a goal in the development stage. In this regard, important aspects are the owner rights (copyright), the development of metadata (description of the educational content and context) and the adaptability of the materials (Pruves et al 2005). When sharing takes place within a single institute, agreements, authorship and metadata are of lesser importance. The teaching staff is already familiar with the materials, has all the rights to adjust the materials and the institute has full ownership.

Re-use of educational materials within Geo-information Science education is of particular interest for a number of reasons. In many cases datasets are used that are not cheap, and sometimes also difficult to acquire. Also the software used is of particular interest. Exercises for example have to be updated frequently for every new version of the software. This is a tedious and re-occurring task. Geo-information Science, like all IT fields, is developing fast and educational materials get easily outdated. Therefore it is advantageous to make intensive use of the materials that are being developed.

Sharing materials between GIS courses within an institute seems to be an obvious choice, but what do we know about the way students regard these shared materials. Do they realise when materials were not developed for their course, does it lead to a different student appreciation?

A comparison was made between a distance course (Distance Education GIS - DEGIS), a blended learning course (combination of face-to-face and e-learning; Geographical Information Management and Applications - GIMA) and a course with pure face-to-face education (Geoinformatics - GFM). In principle, the courses were developed separately, with no explicit intention of sharing materials and ideas, although the e-learning and blended learning courses were developed using the experiences and some materials from the face-to-face education. Although not explicitly required beforehand, the course designs and materials were influenced by each other via the participating teachers. The courses have been running parallel for a number of years. Student numbers have stabilized; face-to-face 90 students per year; distance 60 students per year; blended learning 20 students per year. Enough (student) evaluation data are available to assess if cross fertilization took place and in what respect.

Cross fertilization can take many different forms, ranging from sharing of ideas or concepts to the use of the same teaching materials. Not all influences are directly measurable. This paper concentrates on two main research questions: "Is there a difference in student appreciation between native (developed for the course) and foreign materials (not developed for the course)?" and "How does the way the materials are used (optional versus compulsory, additional to other materials or as the only source) influence the student appreciation?" Answering these questions requires an inventory of materials that are being shared, and how they are used. Equally interesting is the question which materials are not shared and why, but this is beyond the scope of the present article.

This comparison can lead to a better insight into the methods of sharing and re-using materials. The gained knowledge can be applied for the development of universal teaching material that is useful for e-learning, blended learning as well as face-to-face teaching within GI-Science.

2. COMPARABILITY OF COURSES AND COURSE PARTICIPANTS

Ladyshewsky (2004) states that comparison of face-to-face and distance education is hindered by different variables influencing the educational outcome. Variables that are difficult to control include course design, technological applications, pedagogical approaches, student and instructor characteristics and methods of assessment (Volery & Lord, 1999). The three courses presented here are unique in respect to their similarity in educational objectives, course design, and technological applications. All three courses teach a combination of theoretical concepts and practical software skills, and are mainly attended by mid-carrier professionals as part of an MSc program.

Differences that can have an impact on the outcome of this study are:

- Differences in teaching mode
- Differences in course materials and course content
- Differences in participating students.

2.1 Differences in teaching mode

The main difference between these three courses was the mode of teaching. In the face-to-face course, the students had the opportunity to attend regular lectures, practicals and question hours. The course was concluded by an examination.

For the blended learning, the students had 3 contact days at the beginning of the course. During these days the students received instructions on the objective of the course, were introduced to each other and the lecturers and could follow some demonstrations. Contact days are followed by a 12 week period of distance learning. The course was concluded by a two-day contact block. During this block, students received feedback on the submitted tasks and there were question hours followed by an examination. Assessment of this course was based on submitted assignments and the result of the examination.

The distance students followed the complete course at a distance. They received the course material and necessary software via mail on DVD-s and kept in contact with the instructors via the Blackboard educational programme using the World Wide Web. The course was assessed based on hand-in assignments and a distance examination.

There was a difference in the relation between the students in the three different teaching modes: the students in the face-to-face course had day-by-day contact and could develop good social networks (both with other students and teachers). The blended students knew their fellow students and it is known that they had contacts to discuss assignments etc. The distance students had only limited social contact with each other, and the students in this course were not working intensively together.

2.2 Differences in course materials

Course materials included in this comparison are video lectures, e-lectures, self-tests, textbook, ArcGIS exercises and the study guide.

Video lectures include recordings of teachers during a lecture, but also screen captivate movies of instructors performing a certain software task. The video lectures are mostly used in the distance education course, but also provided to face-to-face and blended students as optional material.

E-lectures are the substitute for regular lectures, covering the same content and are closely linked to the content of the textbook. e-lectures are an extended version of the PowerPoint presentations used during face-to-face education. They contain links to exercises and demo-videos. For e-learning students these e-lectures are compulsory, for the other two groups they are optional. The face-to-face students can follow regular lectures that cover the same content, but this is not the case for the blended students.

Self-tests are small tests, provided per topic, that consist of 5 to 15 questions, and are accessible via the digital learning environment. Self-tests are not monitored by the teachers

and students can take a self-test multiple times. Feedback about the correctness of the answers is provided to the students on the completion of the self-test.

ArcGIS exercises are exercises with detailed written eplanations, with challenges at the end that can be completed to test practical skills after doing the exercise. Answers to challenges, questions etc., are provided to the students in additional files.

The study guide is a written document with the practical information about the course. It was adapted for each course; that makes it very difficult to identify to which course it is native, so it can be regarded as native to all three courses.

The blended learning course used several different text books, and in this aspect, it is different from the other two courses which used the same ITC textbook.

Each of the courses included materials, which were originally developed for the other educational methods (Table 1). These materials were not always compulsory and they were not always the only means to get the related information. For example, the e-lectures were added as optional material to the face-to-face education course, but students could also go to the normal lectures, which contained the same information.

	Native (originally developed for...)	GFM face-to-face		DEGIS e-learning		GIMA blended	
		Compul-sory	Inter-changeable	Compuls ory	Inter-changeable	Compulso ry	Inter-changeable
Video lectures	e-learning	No	Partially	Yes	No	No	No
E-lectures	e-learning	No	Yes	Yes	No	No	No
Self-tests	e-learning	No	No	Partially	No	No	No
Text book	face-to-face	Yes	No	Yes	No	Yes	No
ArcGIS exercises	face-to-face	Yes	No	Yes	No	Partially	No
Study guide	all	Yes	Yes	Yes	No	Yes	Yes

Table 1: Status of the materials per course

Materials developed for a type of education are tailored towards this particular use. Differences are most clear in e-lectures and exercises. In e-lectures it is important that students understand the structure of the slides and that the students get all the information on the particular topic (concept) and its applications. Everything that the teacher tells and demonstrates during normal lectures needs to be captured in the structure of the e-lecture, its content and supporting media.

For exercises, the offered materials need to be self explanatory, complete (cookbook structure – guided exercises) and all necessary feedback needs to be provided in the files. In fact we are not talking about a single exercise, but a set of materials that together provide one set of practical instructions.

2.3 Differences in participating students

There are some differences between the student populations of the three analysed courses. First of all, in the origin of the students (Table 2).

Continent	GFM	DEGIS	GIMA
Africa	18.5 %	82.4 %	0.0 %
Asia	55.6 %	11.8 %	0.0 %
Australia	3.7 %	0.0 %	0.0 %
Europe	11.1 %	5.9 %	100.0 %
North-America	0.0 %	0.0 %	0.0 %
South-America	11.1 %	0.0 %	0.0 %

Table 2: Continent of origin of the students

For the face-to-face education, the majority of the students came from Asia, for the distance education the majority originated from Africa and all the blended students came from Europe. Due to the different cultural-technical backgrounds, this can have an impact on the approach towards education and the appreciation of both the course as a whole and the materials used.

Differences in part-time and full-time study approaches were present (Table 3), since the face-to-face education was designed for full-time students, whilst the other two groups were expected to work part time on their studies.

	GFM	DEGIS	GIMA
Part time	3.7 %	82.4 %	66.7 %
Full time	96.3 %	17.6 %	33.3 %

Table 3 Comparison of part-time and full-time students

In regard to prior experience in working with GIS the results are represented in Table 4.

	GFM	DEGIS	GIMA
Yes	18.5 %	29.4 %	33.3 %
Some	48.1 %	41.2 %	33.3 %
None	33.3 %	29.4 %	33.3 %

Table 4 Prior experience in GIS.

The three different student populations do not vary greatly in regard to prior experience in working with GIS. In all groups we see a mixture of the three categories.

3. METHODS

Method applied for the present analysis includes the comparison of student evaluations, questionnaires and a comparison of statistics from the digital learning environment (Blackboard software was used in all the three teaching methods). Anonymous student

evaluations were conducted at the end of each course, although different evaluation forms were used in the different courses, since the original idea was getting a feedback from the course participants and not the comparison which is presented here. For increasing the comparability of the different information sources, it was decided to develop a new questionnaire with the same questions for all of the students and send this questionnaire to all students that participated in the last run of each course. The questionnaire consisted of two parts, the first part contained questions about the course materials and the second part asked some general questions to compare the student populations.

Answers were on a scale of '+ +' to '– –' (5 categories). A total of 50 completely filled out questionnaires were returned.

Evaluations of all three courses were conducted in the digital learning environment (Blackboard) and contained both multiple choice (scaling) questions and open questions. Course evaluations were compulsory and filled out anonymously during the last days of the course.

Statistical information about the use of the different services of the digital learning environment was also used for the analysis. In this statistical information it can be checked how many students used a certain course item (for example the self-tests). This is an independent source of information that we used to check the results for both the questionnaires and the evaluation forms.

4. RESULTS

First, the results of the questionnaire, which was filled up by students of all the three course types will be discussed and these results will then be compared to the student evaluations and the course statistics provided by Blackboard.

Table 5 shows the results for the use of the materials. In this table native materials are indicated in bold and italics (shaded).

	++			+			+/-			-			--		
	GFM	DEGIS	GIMA	GFM	DEGIS	GIMA	GFM	DEGIS	GIMA	GFM	DEGIS	GIMA	GFM	DEGIS	GIMA
Video lectures	18.5	***64.7***	66.7	33.3	***29.4***	16.7	29.6	***5.9***	16.7	0.0	***0.0***	0.0	18.5	***0.0***	0.0
E-lectures	22.2	***76.5***	33.3	44.4	***11.8***	50.0	19.8	***5.9***	16.7	3.7	***0.0***	0.0	11.1	***5.9***	0
Self-tests	40.7	***70.6***	66.7	44.4	***17.6***	33.3	11.1	***5.9***	0.0	0.0	***5.9***	0.0	3.7	***5.9***	0
Text book	***77.8***	76.5	16.7	***18.5***	17.6	33.3	***3.7***	5.9	16.7	***0.0***	0.0	0.0	***0.0***	0.0	33.3
ArcGIS exercises	***29.6***	70.6	33.3	***55.6***	17.6	16.7	***14.8***	0.0	16.7	***0.0***	5.9	16.7	***0.0***	5.9	16.7
Study guide	7.4	47.1	33.3	66.7	35.3	16.7	11.1	11.8	16.7	7.4	0.0	16.7	7.4	5.9	16.7

Table 5 Extent to which the materials were used in the different courses in percentage.

The materials were used most intensely by the e-learning students (Table 6).

	Sum of ++ and + in Table 5		
	GFM	**DEGIS**	**GIMA**
Video lectures	51.8	***94.1***	83.4
E-lectures	66.6	***88.3***	83.3
Self-tests	85.1	***88.2***	100
Text book	***96.3***	94.1	50
ArcGIS exercises	***85.2***	88.2	50
Study guide	74.1	82.4	50

Table 6: Extent to which the materials were used in the different courses, combination of ++ and + of Table 5

The average use for the distance students is 89.2%, for the face-to-face education this is 76.5% and for the blended learners it is 69.5%. Both the face-to-face and the distance students made a lot of use of the textbook (developed for the face-to-face education), blended learners made the most use of the self-tests (developed for the distance course). Distance and blended students have a much higher use for video lectures and e-lectures than the face-to-face education.

The next question was how much the materials contributed to the learning process. Results are shown in Table 7.

	++			**+**			**+/-**			**-**			**--**		
	GFM	**DEGIS**	**GIMA**	**GFM**	**DEGIS**	**GIMA**	**GFM**	**DEGIS**	**GIMA**	**GFM**	**DEGIS**	**GIMA**	**GFM**	**DEGIS**	**GIMA**
Video lectures	20.8	***41.2***		49.9	***35.3***		25.0	***23.5***		0	***0***		4.2	***0***	
E-lectures	38.4	***68.8***	66.7	30.7	***25.0***	33.3	19.2	***6.3***	0	3.8	***0***	0	7.7	***0***	0
Self-tests	60.0	***75.0***	16.7	36.0	***18.7***	50.0	4.0	***0***	16.7	0	***6.3***	0	0	***0***	0
Text book	***80.0***	82.4	16.7	***20.0***	5.9	50.0	***0***	11.8	33.3	***0***	0	0	***0***	0	0
ArcGIS exercises	***55.6***	64.7	20.0	***37.0***	23.5	40.0	***7.4***	5.9	0	***0***	5.9	20.9	***0***	0	20.9
Study guide	16.6	***47.1***	16.7	66.7	***35.3***	16.7	12.5	***5.9***	33.3	4.2	***5.9***	0	0	***5.9***	0

Table 7 Comparison of the contribution of the learning materials to the learning process in percentage of total number students who used the materials per course

In the table native materials are indicated in bold and italics. Scores are in percentage and have been corrected for students that did not use the materials. General trend is that the appreciation of the e-learners for all materials is the highest. This also applies for materials that were not originally made for this course.

The statistics of the positive appreciation is shown in Table 8.

	GFM	**DEGIS**	**GIMA**
Video lectures	70.8	***76.5***	
E-lectures	69.2	***93.7***	100.0
Self-tests	96.0	***93.7***	66.7
Text book	***100.0***	88.3	66.7
ArcGIS exercises	***92.6***	88.2	60.0
Study Guide	83.4	82.4	33.4

Table 8 Combined scores of appreciation for the categories '+ +' and '+' in percentage of total students who used the materials per course

The face-to-face students had the highest appreciation for the text book (100 % for categories 1 and 2 together), this is indeed their native material. Second came the self-tests, with a score of 96 %; the self-tests were developed for the e-learning course and were added as extra material in the other courses.

The distance students had the highest appreciation for e-lectures and self-tests (both 93.7 %). Both were developed for this mode of education. It is followed by the textbook with a score of 88.3 %. The text book is not native to this type of education.

The overall appreciation of the teaching materials by the students of the blended learning course was lower than in the other two courses. Average score over two categories ('++' and '+') and all materials for the blended learners was 65.4 %, compared to the 85.5 % for the face-to-face and 87.1 % for the e-learners. Remarkable is the result for the blended learning is the 100 % appreciation for the e-lectures. This material was originally developed for the e-learning course.

Comparison of the results of the questionnaires with the course evaluations and statistical information of the digital learning environment yielded the following results.

For the blended students, the evaluation contained a question related to the study guide. The use of the study guide was rated as very useful, useful or no response.
A total of 15 students answered this question of which 11 indicated that it was very useful and 4 indicated that it was useful. This is contrary to the score for the study guide in the questionnaire. Apparently the students were much more positive about this material in the course evaluation.

Distance students were asked in the evaluation if they used the self-tests to asses the progress they made. They scored the question on a scale of 5 grades (comparable to the scale from '++' to '– –'). The score of the first two categories in the questionnaire was 88.2 %, whilst the score in the evaluation was 87.5 %. These results are practically the same.

When using the statistics from the digital learning environment, use of the self-tests for the blended learners show a use of 70 %, use of face-to-face students shows a use (all self-test) of 61%. These numbers are in fact lower than the values for self-tests found in the questionnaires.

For the face-to-face education, students were asked if e-lectures and videos were an important addition to the text book. 79 % of the students agreed, and another 12 % more agreed than disagreed. Course evaluation here shows a more positive appreciation than the questionnaires.

5. DISCUSSION

Materials were shared by all three courses, including materials that were developed for e-learning and are now used in face-to-face education. In general there is no difference in the appreciation of foreign materials compared to native materials. However, there is a difference

in the student appreciation based on the use of the materials. Optional and interchangeable materials have a lower appreciation than compulsory non-interchangeable materials.

We see that the appreciation for e-lectures is high for e-learners and blended learners (88.3 %). These groups have no access to face-to-face lectures. The score for face-to-face education for e-lectures is 69.2 %. For this group the e-lectures are both optional and interchangeable (i.e. the same information can be obtained by other means). Taking this into account a score of almost 70 % ('+' and '++') can be considered very high, so we can conclude that it was useful to provide this material to the face-to-face students. The same applies for the ArcGIS exercises. These exercises were compulsory for both face-to-face and distance education students but optional for the blended learners. Score for GFM (92.6 %) and DEGIS (88.2 %) is considerably higher than for GIMA (60 %) but even the GIMA score is not very low.

In general, we conclude that there is a clear relationship between the use and appreciation of the material and the fact that the material is optional/interchangeable. This usually results in a lower use and appreciation but the score of the optional materials is still considerably high.

Some differences were found between the results of the questionnaires, the course evaluation and the statistics derived from the digital learning environment. Sometimes the questionnaires showed more positive results, sometimes the course evaluation. A factor of influence can be that the questionnaire was filled out weeks after the completion of the course, but the evaluations date from the end of the course. It was not possible to find a clear trend in the differences, so we can conclude that the questionnaires can be used as the basis of the analysis.

Differences in student population can play a role in the results of this research. The face-to-face and distance students were mainly students for which English is a second language. This could have an effect on the high appreciation of e-lectures. E-lectures are repeatable, and reading is sometimes easier than listening to a regular lecture. The blended learners were European students, and in general they had better English language skills.

There are some differences in appreciation between the learning materials. Materials with an overall high appreciation are the self-tests and the textbook. A high appreciation for a textbook is in line with general expectations. The high appreciation for self-tests, and the relative high appreciation for e-lectures in face-to-face education are of particular interest. It would be interesting to conduct a second comparison after the next run of the three courses using the same evaluation including the questionnaire questions for all the three courses. Additional questions could investigate the way the materials like e-lectures and self-tests are used by the different groups. The actual use of the materials may be different from the intended use. Further research would also offer the possibility to investigate what exactly the added value is of the different types of materials in the different courses.

Although foreign materials are used and appreciated this does not mean that all materials can be shared, or that sharing materials is a means to save staff time in the development or execution of a course. The materials that were shared (e-lectures, selftests, video-lectures) are

materials that are relatively time consuming to make. Exercises that were shared are self instructing sets of exercises including additional information like answer sheets. Certainly not all materials from face-to-face courses are suitable for sharing.
In the courses researched here the distance materials that were used in face-to-face education were all used as additional (optional) materials. Findings may not apply when the materials would be used to replace course items from the face-to-face course.

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BIOGRAPHICAL NOTES

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