The challenge of virtual mobility: pedagogical models and good practices

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THE CHALLENGE OF VIRTUAL MOBILITY: PEDAGOGICAL MODELS AND GOOD PRACTICES

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Abstract

The notion of virtual mobility has gained prominence not only in the field of distance education. Virtual mobility is entrenched in the idea to enable students to exchange and collaborate with teachers and fellow students from other countries by the means of the latest information and communication technologies (ICT). In this paper, we argue that especially non-traditional students regularly found in distance education can benefit from virtual mobility as they are normally omitted from regular exchange programs. However, hitherto there is little empirical data about how to best implement virtual mobility in courses in distance education. We therefore present our own experiences with developing a university course which implemented virtual mobility. The course brings together students from two Master programmes in Finland and Germany. We used the ADDIE model which allowed us to tailormade the course striving to enhance the learning experience of the students. Seamless learning, problem-based learning and peer-assessment were implemented as activities to spur the students' interaction and thereby enriching their experience with virtual mobility. The results of our evaluation are twofold. First, students indicate a high level of satisfaction with the instructional course design, the different activities and the collaboration with fellow students from abroad. Second, the results suggest that students need additional assistance as well as skill improvement and training to be able to perform eLearning. In a nutshell, the ADDIE model proved to be valuable for instructional course design by allowing testing and evaluating the merits and risks of a course with virtual mobility.

Keywords: Virtual Mobility, Seamless Learning; Peer-Assessment; Higher Education; eLearning, Distance Education, ADDIE Model.

1 INTRODUCTION

Virtual mobility is rooted in the idea to enable students to exchange and collaborate with teachers and fellow students from other countries by the means of the latest information and communication technologies (ICT). As a result of the advancements in distance education and digital learning, the concept of virtual mobility is increasingly receiving attention in the literature [1]–[3]. Non-traditional students regularly found in distance education can especially benefit from virtual mobility as they are normally omitted from regular exchange programmes. Starkly simplified, non-traditional students can be characterized as significantly varying in age and academic background, they often study part-time, are already working, have children and some are single parents [4]. Against this background, virtual mobility is perceived as an opportunity for non-traditional students to gain international and intercultural experiences with fellow students from abroad. Notwithstanding its promising potential, hitherto there is a lack of empirical experiences identifying ways to design and implement virtual mobility in university courses and to determine key factors for the students' learning experience [3]. This paper is based on the main argument that a fruitful and rewarding learning experience with virtual mobility requires an elaborated planning of the instructional course design which aligns content and learning outcomes with suitable teaching methods and respective online activities.

In the following we present results from the online course "Energy and Energy Efficiency: Technology and Policy" which brings together students from two Master programmes in Finland and Germany. For the instructional course design, we used the ADDIE model which follows a stepwise approach encompassing five phases of Analysis, Design, Development, Implementation, and Evaluation [5]. Consistent with the objective of virtual mobility, the ADDIE model aims to make the learning experience in the course student centered, innovative, authentic, and inspirational [5]. In our course, seamless learning, problem-based learning (PBL) and peer-assessment were implemented as key activities to accomplish our intentional learning.

As for the structure of the paper, in the following section, we present our instructional course design based on the ADDIE model. The methodological approach for the course evaluation is briefly outlined

in section three. In the fourth section, we present and discuss the results of the evaluation. Conclusions and a brief outlook are offered in section five.

2 INSTRUCTIONAL COURSE DESIGN

For the instructional design of the course “Energy and Energy Efficiency: Technology and Policy” and the implementation of virtual mobility, we used the ADDIE model as the most prevailing instructional design model [6]. Although several different theories about the origins of the ADDIE model exist, it can best be characterized as an umbrella term capturing a variety of instructional designs [7]. As a common denominator, all follow a five step approach encompassing the phases of Analysis, Design, Development, Implementation, and Evaluation [5]. Several empirical studies in numerous contexts have underscored that following these five phases of instruction can improve the overall quality of courses and enhance the learning experience for students [5], [8]. In the following, we elaborate our instructional course design following the five phases of the ADDIE model.

2.1 Analysis

Often overlooked in the ADDIE model, the ANALYSIS phase is crucial as it encompasses an examination of the learners, the course objectives and the online delivery medium [8]. In our case and often found in distance education, the learners/students can be characterized as non-traditional with an interdisciplinary academic background. This diversity was enriched by bringing together distance students from Finland and Germany. The final course is offered completely online in both Master programmes and awarded with 10 ECTS (300 working hours). As technical infrastructure we use a Moodle 3 platform.

The students represented different professional, demographic and interdisciplinary backgrounds. We tried to consider these diversity when we formulating our intended learning outcomes. The intended learning outcomes of the course are that students:

- Are able to take an interdisciplinary approach to the topic
- Demonstrate knowledge and competences to operationalise the concept of energy efficiency and energy policy
- Are able to apply the knowledge and competences to a concrete case study
- Increase their level of the English language in an environmental sciences context
- Are able to work together in international teams
- Are able to assess scientific quality based on objective criteria.

In the next step of the ADDIE model, it is important to carefully select the pedagogical methods against the background of the intended learning outcomes. Particularly in distance learning, aligning teaching methods with corresponding online activities plays a key role for enhancing students’ interaction. According to the literature, this is one central variable for the students learning experience [9]. Shelton and Saltsman recommend considering some mixture of experiential, problem-based, and constructivist approaches to learning [8]. The following teaching methods that we implemented in our course were selected to use the interdisciplinarity and diversity among the students to our advantage. Based on a review of the literature, seamless learning, problem-based-learning and peer-assessment were identified as suitable learning activities. All three allow students to mutually benefit from each other’s experiences by bringing in their different demographic and professional backgrounds.

Seamless learning is a technology enhanced learning activity which permits students to learn wherever they want using their mobile or portable devices [10]. Although still loosely defined, seamless learning refers to the usage of mobile or portable devices in a variety of learning scenarios and learning contexts (for example formal and informal learning) [11]. In our course, seamless learning was used as a mediator to contextualize the previous acquired knowledge and professional skills for both introspection of and application in one's own life. Sharing the results and practices with other students in the learning platform, assisted by the teachers, fosters the knowledge and thereby triggers mutual learning.

The second course activity refers to *problem-based-learning (PBL)*. PBL is a method of learning through the experience of solving problems [12]. In our course, students were instructed to form groups to collaboratively apply their knowledge and skills for solving a concrete problem. In a process

of self-directed learning (SDL), facilitated by the teachers, they engage in testing new strategies and learn through the experience of solving problems. Their final delivery is a written group research report which has to be uploaded in the learning platform.

The final activity is to peer-assess the research report of another group. *Peer-assessment* can be defined as a process through which groups or individuals assess their peers. Research has demonstrated that learning to assess and give feedback (in qualitative or quantitative manner) on the work of other peers based on objective criteria or instruments can lead to skill development [13]. Learning then goes beyond solely content through enabling to reflect one´s own behaviour (self-assessment) and that of peers (peer-assessment) [14]. Experiences with peer-assessment show that students are mostly fair and accurate in their assessment. To implement our peer-assessment activity, we used the peer-assessment software that is provided in the Moodle 3 platform. For the students, instructions of how to perform the peer-assessment were provided in the platform. In addition, we presented a list of criteria about how to give feedback to a peer group.

For supporting the students to regulate their own learning path and strategies, we decided to use formative assessments for a constant qualitative feedback on the different activities throughout the course. According to the literature, continuous feedback is fruitful for the students if it (a) provides a reference level to aim for, (b) collates the performance with this level and (c) offers guidance on how to achieve it [15].

2.2 Design and Development

The DESIGN phase comprises to organize the strategies, activities and objectives that were carved out in the analysis phase [8]. The previously identified framework conditions and learning activities are transferred into an engaging course design. In the subsequent DEVELOPMENT phase, the results are yielded by producing concrete and tangible results in form of content, course structure (activities, assessment and additional resources) and a review of the course objectives [8].

In this section, the two steps of design and development were merged for the reason of simplicity and transformed into a final course structure. As visible in the table below, all activities identified during the analysis phase were incorporated and implemented in the course design.

Table 1. *Course design after the design and development phase.*

Course structure	Content	Activity	Formative Assessment	Duration
Task 1: Introduce yourself to the other course members		✓ Introduce to other course members		*11th of September*
Kick-off online meeting via Adobe Connect	▪ Meet with fellow students and teachers to receive introduction to the course	✓ Active participation		*18th of September*
Study Module 1 about "Energy Supply of Objects"	▪ Video lectures ▪ Written course material	✓ Study course material ✓ Quiz for self-assessment	*Quiz for self-monitoring performance*	*11th of September – till 9th of October*
Task 2: Improve the energy situation in your private home or working place (seamless learning)	▪ Produce one page proposal of how to Improve the energy efficiency/supply of your private home or working place	✓ Write proposal and include data, photos or a small video to support and illustrate your written text.	*Qualitative feedback on Proposal*	*Until 9th of October*
Study Module 2 about "Energy Efficiency Policy"	▪ Written course material ▪ Video lectures	✓ Study course material		*9th of October till 30th of October*

Task 3: Write common Group Report (problem-based-learning)	▪ Based on content of Module 2, write a common group research report about the implementation of an energy efficiency policy measure	✓ Collaborate with others ✓ Identify problem ✓ Research and write report	*Qualitative feedback during writing process*	*Till 27th of November*
Submitting the group report		✓ Upload report via learning platform		*Deadline 27th of November*
Task 4: Peer-assessment		✓ Peer assessment of another group report	*Qualitative feedback on quality of peer-assessment*	*27th of November till 10th of December*
Course Evaluation	▪ Survey and interviews about experiences with the course	✓ Individual interviews via Skype about course experiences. ✓ Answer survey		*27th of November to 11th of December*

As the first task, students had to introduce themselves by providing a short self-description in the learning platform. During the kick-off meeting after the first week, the different activities and the learning outcomes were made transparent to the students. The course content was delivered in different formats and consisted of written (pdf, eBook) and video material. The seamless learning activity was performed after the end of Module 1, so that students were able to apply their new knowledge and skills by connecting it to their personal environment. Sharing their results in the learning platform was intended to stimulate mutual exchange and thereby to trigger learning. After having established a common knowledge base, writing a research report in groups was envisioned to stimulate collaboration and exchange among the students and thereby reducing the incentive to drop-out. Teachers in this process acted as facilitators, encouraging the students to engage in SDL. Based on the diversity of demographic and professional backgrounds, prior knowledge should be activated in the groups for the identification of a problem and corresponding problem-solving strategies. The outcomes of this process should then be tackled and reflected in the research report. Peer-assessment of the final reports was supposed to strengthen the students' skills through assessing and evaluating the quality of research based on objective criteria. In this manner, peer-assessment can result in an improved assessment of scientific work and to accept judgments of the own contribution by other peers.

2.3 Implementation and Evaluation

The IMPLEMENTATION phase mainly involves testing the course design. The level of complexity, technical and practical feasibility as well as the compatibility with the intended learning is measured. In our case, the implementation phase was started by offering the course as a pilot at the end of 2017. Incentives of reduced fees and testing an innovative new course were offered in exchange for participating in a comprehensive evaluation of the learning experience. The EVALUATION phase consisted of a survey about the course design and the learning experience [8]. The learning performance and the learning experiences are measured against the background of the course objectives. The survey about the course design was supposed to deliver more detailed information on what worked and what has to be further improved to enhance the overall quality of the course.

3 METHODOLOGY

The course was offered as a pilot in 2017. Overall, 15 students participated, 10 from the German university and 5 from the Finnish university. The evaluation consisted of a first quantitative survey at the beginning and a second at the end of the course. Completing both surveys was mandatory to finish the course. In addition, we conducted semi-structured interviews with the students after the end of the course to gain in-depth insights of their learning experience and their overall satisfaction with

the course. The interviews are currently examined and thus cannot be considered for this paper. As already described, in both Master programmes the students can be characterized as non-traditional (table 2).

Table 2. *Course participants*

Course	Students	Nationality		Gender		Professional background
Pilot course	15	German (8)	Finnish (5)	Male (9)	Female (6)	Social science (2)
		Canadian (1)				Natural science (10)
		Austrian (1)				Economic science (3)

4 RESULTS

The overall goal of the evaluation in the form of a pre- and post-survey was twofold. First, we surveyed the students' course expectations with a pre-survey and compared the results with the learning experiences the students indicated in the post-survey. Second, the post-survey was intended to receive feedback on the course design for further improvement. The course design included among others the teaching methods, the online activities, the structure and the formative assessments.

4.1 Pre-survey

In terms of their course expectations and previous experiences with eLearning, the survey reaffirmed the diversity of experiences among the students. While the evaluation points to a moderate level of the students' experiences with eLearning (2.73), at the same time they uttered high learning expectations from their participation in the course. Besides expectations to generally increasing their level of knowledge and skills about the topic (4.60), the course was estimated to be beneficial for the educational future (4.43). As a first observation, the expectation to learn in terms of content was high while experiences and expectations related to eLearning were rather low.

Table 3. *Previous experiences and course expectations of students*

Question or statement [scale from 1 (very low) to 5 (very high)]	Mean (n15)
How do you self-assess your experiences with eLearning?	2.73
I expect the course to enhance my level of knowledge and skills about the topic	4.60
I expect the course to enhance my skills in the field of eLearning	3.73
I expect the course to enhance my skills in intercultural communication	4.00
I expect the course to enhance my knowledge and skills for my educational future	4.43
I expect the course to enhance my knowledge and skills for my future work	4.07

Virtual mobility as one central feature of the course should enable students to exchange and collaborate with teachers and fellow students from other countries. Almost all students indicated their eagerness to collaborate with fellow students (93.33%) and students from other countries (73.33%). Mutual exchange and collaboration can therefore be regarded as a key reason for the course participation as no other optional answer was indicated by the students.

Table 4. *Course expectations on personal level*

What do you expect from the course from a personal level	n15	Percentage	
to exchange with fellow students	14	93.33%	
to exchange with teachers and tutors	12	80.00%	
to exchange with students from other countries	11	73.33%	
improve my English	5	33.33%	
other:	0	0.00%	

4.2 Post-survey

The survey conducted after the course was designed to disclose the students' learning experiences and assessment of the course design. We were in particular interested in the students' experiences with the different activities that were implemented on the basis of the ADDIE model. As a first noteworthy observation, all 15 students that started the course finished it and received a certificate of competition. They all participated successfully in the different activities and all groups managed to upload their final research report and peer-assessed that of another group. In terms of the pre-defined workload/working hours, the course can be assessed as workable.

4.2.1 Learning experiences

The post-survey shows that the high learning expectations of the students could be met. All surveyed items received high approval with *broaden my knowledge about the topic* being the highest (4.43). Again improving skills in eLearning received the lowest mean (3.80) with two students rather disagreeing with the statement.

Table 5. *Assessment of course achievements*

My participation in the course was helpful:	fully disagree (1)	rather disagree (2)	neither agree nor disagree (3)	rather agree (4)	fully agree (5)	n15	Mean
to broaden my knowledge about the topic of energy	0.00% (0)	0.00% (0)	7.14% (1)	42.86% (6)	50.00% (7)	14	4.43
to improve my skills in the field of eLearning	0.00% (0)	13.33% (2)	13.33% (2)	53.33% (8)	20.00% (3)	15	3.80
to improve my intercultural communication	0.00% (0)	0.00% (0)	20.00% (3)	73.33% (11)	6.67% (1)	15	3.87
for my current/future educational achievement	0.00% (0)	0.00% (0)	6.67% (1)	80.00% (12)	13.33% (2)	15	4.07
for my current/future work	0.00% (0)	0.00% (0)	20.00% (3)	53.33% (8)	26.67% (4)	15	4.07

In terms of the course design, the survey demonstrates that for the vast majority of the students the learning outcomes were achievable and clearly communicated (3.87). The learning activities and the learning outcomes were assessed as appropriate (4.00) and the students felt that they achieved them (4.20). They particularly valued the mixture of videos and written material (4.07). The kick-off online meeting was considered as helpful (4.14) and thus supports the claim of the literature that early interaction is crucial for the learning success in online and distance learning. However, the survey also shows that there is a need to improve the structure and design of the learning platform (3.00). This deficit detected reinforces the importance of receiving feedback from the students regarding problems and challenges.

Table 6. *Course design*

Concerning the content and structure of the course	strongly disagree (1)	disagree (2)	neither agree nor disagree (3)	agree (4)	fully agree (5)	n15	Mean
the learning outcomes of the course were clearly communicated	0.00% (0)	6.67% (1)	26.67% (4)	40.00% (6)	26.67% (4)	15	3.87
I reached the learning outcomes of the course	0.00% (0)	0.00% (0)	13.33% (2)	53.33% (8)	33.33% (5)	15	4.20
the learning activities/task were appropriate to reach the learning outcomes	0.00% (0)	0.00% (0)	26.67% (4)	46.67% (7)	26.67% (4)	15	4.00
the course content was a good combination of videos and written material	0.00% (0)	0.00% (0)	13.33% (2)	66.67% (10)	20.00% (3)	15	4.07
the Adobe meeting at the beginning of the course was helpful	7.14% (1)	0.00% (0)	7.14% (1)	42.86% (6)	42.86% (6)	14	4.14
the learning platform was well-structured and clear in design	6.67% (1)	26.67% (4)	33.33% (5)	26.67% (4)	6.67% (1)	15	3.00

In the next step, we asked the students to what extend the different activities contributed to their learning success. Not surprising, task 1 where the students had to introduce themselves received the lowest score (3.33). That low score may be rooted in the fact that task 1 rarely contributed to the learning outcomes in the course but was understood as an ice breaker activity. Task 3, the research report, on the other hand was perceived as being the most valuable (4.53). Noteworthy, this task involved the highest level of collaboration and interaction among the students and supports the findings from the literature that students' interaction is crucial for the learning experience [9].

Table 7. *Assessment of tasks*

The following tasks have contributed to my learning success	fully disagree (1)	rather disagree (2)	neither agree nor disagree (3)	agree (4)	fully agree (5)		Answers	Mean
Task 1: Introduce yourself to the other course members	13.33% (2)	0.00% (0)	33.33% (5)	46.67% (7)	6.67% (1)		15	3.33
Task 2: Improvement of Energy Efficiency at home or at work	0.00% (0)	0.00% (0)	0.00% (0)	73.33% (11)	26.67% (4)		15	4.27
Task 3: Group research report about an energy efficiency policy	0.00% (0)	0.00% (0)	0.00% (0)	46.67% (7)	53.33% (8)		15	4.53
Final task: Peer-Assessment of the group work	0.00% (0)	0.00% (0)	13.33% (2)	66.67% (10)	20.00% (3)		15	4.07

This impression is reinforced when in the survey the students had to specify the most enjoyable learning task of the course. 13 students specified that task 3 was either the most or second best activity. Task 2 follows as the second best activity being mentioned 8 times. Peer-assessment and the introduction follow with significant lower approval.

Table 8. *Ranking of tasks*

Which of the tasks did you enjoy the most?	Overall	Mean	Median	Standard deviation	missing		1	2	3	4
Task 1: Introduce yourself to the other course members	3	3.67	4.00	0.58	12		0	0	1	2
Task 2: Improvement of Energy Efficiency at home or at work	8	1.38	1.00	0.52	7		5	3	0	0
Task 3: Group research report about an energy efficiency policy	12	1.17	1.00	0.39	3		10	2	0	0
Final task: Peer-Assessment of the group work	4	3.25	3.00	0.50	11		0	0	3	1

Finally, the survey evaluated the added value of virtual mobility being operationalised as the extent to what the course encouraged to exchange with fellow students from abroad. The vast majority of the students stated that the course had contributed to the exchange with fellow students (4.43) as well as students from other countries (4.33). The instructional design of the course can therefore be considered as suitable to encourage the students' interaction and collaboration in a virtual mobility setting.

Table 9. *Course design*

The course has contributed:	fully disagree (1)	rather disagree (2)	neither agree nor disagree (3)	rather agree (4)	fully agree (5)		Answers	Mean
to exchange with fellow students	0.00% (0)	0.00% (0)	0.00% (0)	57.14% (8)	42.86% (6)		14	4.43
to exchange with teachers and tutors	0.00% (0)	0.00% (0)	20.00% (3)	73.33% (11)	6.67% (1)		15	3.87
to exchange with students from other countries	0.00% (0)	0.00% (0)	6.67% (1)	53.33% (8)	40.00% (6)		15	4.33

5 CONCLUSION

Our paper was based on the assumption that virtual mobility can be a fruitful and rewarding experience for non-traditional students in distance education. As previously outlined in this paper, this requires an instructional course design according to the students' needs and against the background of the intended learning objectives. Albeit we provided a small case study, some preliminary results can be inductively derived to inform the broader debate. First, in our case, the ADDIE model has proven to be a valuable tool for our instructional course design. Following the five steps of the ADDIE model secured an elaborated planning process, adequate testing, and the identification of strength and weaknesses of our course. The stepwise approach ascertains that required action for design and further improvement of a course can be identified and implemented. Second, the results of our evaluation show a high satisfaction of the students with their learning experience and virtual mobility. The high expectations of the students at the beginning of the course could be met. The students especially valued the opportunity to exchange and collaborate with fellow students and students from other countries. Virtual mobility in a proper and appealing course design can therefore serve as a prospect for non-traditional students to gather international experience. Third, our results confirm that collaboration and mutual exchange enrich the students' learning experience. Integrating suitable and innovative teaching methods and activities in the course is therefore a logical corollary. However, through the evaluation it also became apparent that students need better training and instructions to cope with the special requirements of eLearning. This needs to be address during the revision of the course. Lastly and for further discussion, it would be desirable to share other best practices to further

promote virtual mobility. It would especially be stimulating to have case studies about how to implement, test and evaluate new and innovative concepts and teaching methods.

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REFERENCES

[1] M. Tereseviciene, A. Volungevičienė, and E. Daukšienė, 'Fostering Internationalisation in Higher Education by Virtual Mobility', *Acta Technologica Dubnicae*, vol. 3. p. 1, 2013.

[2] I. Op de Beeck and W. Van Petegem, 'Virtual mobility: An alternative or complement to physical mobility?', in *ERACON 2011 & 2012 Dual Year Proceedings*, 2013, pp. 151–160.

[3] M. Vriens, W. Van Petegem, and M. Achten, 'Virtual Mobility As an Alternative or Complement To Physical Mobility?', in *Edulearn 10 Proceedings. 2nd International Conference on Education and New Learning Technologies*, 2010, no. July, pp. 6695–6702.

[4] H. G. Schuetze and M. Slowey, 'Participation and exclusion: A comparative analysis of non-traditional students and lifelong learners in higher education', *Higher Education*, vol. 44, no. 3, pp. 309–327, 2002.

[5] R. M. Branch, *Instructional Design: The ADDIE Approach*. Boston, MA: Springer US, 2009.

[6] K. Gustafson and R. M. Branch, *Instructional design models*. Syracuse, NY: ERIC Clearinhouse on Information and Technology, 1997.

[7] M. Molenda, 'In search of the elusive ADDIE model', *Performance Improvement*, vol. 42, no. 5, pp. 34–36, 2003.

[8] K. Shelton and G. Saltsman, 'Applying the ADDIE model to online instruction', *Instructional design: Concepts, methodologies, tools, and applications*, no. 2003, pp. 41–58, Jan. 2008.

[9] D. Otto, 'Students' interaction for enhancing learning motivation and learning success: findings from integrating a simulation game into a university course', in *International Technology, Education and Development Conference*, 2017, pp. 1316–1324.

[10] C.-K. Looi, P. Seow, B. Zhang, H.-J. So, W. Chen, and L.-H. Wong, 'Leveraging mobile technology for sustainable seamless learning: a research agenda', *British Journal of Educational Technology*, vol. 41, no. 2, pp. 154–169, Mar. 2010.

[11] L.-H. Wong, 'A learner-centric view of mobile seamless learning', *British Journal of Educational Technology*, vol. 43, no. 1, pp. E19--E23, 2012.

[12] C. E. Hmelo-Silver, 'Problem-based learning: What and how do students learn?', *Educational Psychology Review*, vol. 16, no. 3. pp. 235–266, 2004.

[13] F. Dochy, M. Segers, and D. Sluijsmans, 'The use of self-, peer and co-assessment in higher education: A review', *Studies in Higher Education*, vol. 24, no. 3, pp. 331–350, Jan. 1999.

[14] D. M. A. Sluijsmans, G. Moerkerke, J. J. G. van Merriënboer, and F. J. R. Dochy, 'Peer assessment in problem based learning', *Studies in Educational Evaluation*, vol. 27, no. 2, pp. 153–173, 2001.

[15] D. R. Sadler, 'Formative assessment and the design of instructional systems', *Instructional Science*, vol. 18, no. 2, pp. 119–144, 1989.