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A THEORETICAL FRAMEWORK TO ANALYZE STUDENTS' FORMATIVE FEEDBACK ON CLASSROOM TEACHING

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ABSTRACT - Increased rate of adoption of digital technologies in tertiary education has made the quality assessment of teaching sessions a complex problem. Students feedback on teaching sessions can be associated with technology, pedagogy, content and teachers' interaction and performance. Students motivation and the feedback on classroom activity sessions are subjective and quick analyses of anonymous responses can be misleading. So, the multi-tier problem this paper addresses are: a) a method for collecting qualitative formative feedback from students, b) absence of a framework or tool for analyzing the feedbacks and c) attributing with measurement scores even for opposing statements. Moodle's feedback activity and adapted three questions of Google form's exit ticket is used to collect feedback on six four-hour teaching sessions from 58 master students of a Danish university. Applying Grounded Theory to analyze the feedbacks, theory on three motivational components of learners, and review on barriers to ICT use, a theoretical framework is proposed as a rubric for analyzing formative feedback on teaching or learning sessions. The vision is to use the framework to automate the analysis of feedback sessions toward the development of dashboard for teachers and personalized learning environment.

Keywords: Learning Analytics; Educational Technology; Formative Feedback; Data mining; Grounded Theory.

1. INTRODUCTION

Increased rate of adoption of information and communication technologies (ICTs) in education has made the quality assessment of teaching sessions a complex problem. The use of different types of digital technologies is ever-increasing, namely, teaching sessions mediated by video conferencing (Khalid & Hossan, 2016), use of projectors and smartboards, clickers, mobile devices, cloud systems (Hartmann, Braae, Pedersen, & Khalid, 2017), and virtual reality systems (Yu & Khalid, 2019). Typically, tertiary-level course evaluations of such technology-integrated classes are conducted once per semester and not by formatively. Moreover, recalling the experiences and reflecting on activities become a challenge if the evaluations are not conducted by session. Being that students' assessments are subjective, establishing redesign decisions about a course or session often becomes difficult.

Traditionally, the two central learning analytics categories are (1) teachers' assessment of students' learning progression and learning activities, and (2) students' assessment on teaching-learning activities of a course. The recent development of educational data science and learning analytics has made advancements by applying algorithms and developing applications for interpreting online interactions, data mining for identifying patterns and dependency factors, and by developing dashboards for providing insights and suggesting actions (Baker and Inventado, 2014; Siemens and Baker, 2012; Gutiérrez et al., 2018). Theoretical frameworks are required to apply algorithms and computational methods. For analyzing students' feedback on each of the sessions of an ICT-supported classroom a theoretical framework is pre-requisite developing algorithms and applying computation methods. The TPACK framework (Koehler and Mishra, 2009) contributed the first step by presenting knowledge dimensions involving technology, pedagogy and content. However, this broad framework is not sufficiently detailed and includes complex overlaps among the dimensions. In addition, according to Black & Wiliam (2006), formative assessment is defined as "(…) *encompassing all those activities undertaken by teachers, and/or by their students, which provide information to be used as*

feedback to modify the teaching and learning activities in which they are engaged." This paper devises a formative assessment framework for teachers by mapping factors identified from students' open-ended feedback of a video-conference-mediated course in a Danish context.

Literature shows that the integration of multimedia and digital technologies prerequisites teacher knowledge and skills in technology, pedagogy and content (Hew and Brush, 2007; Koehler and Mishra, 2009). These barriers are typically associated with teachers' beliefs about teaching and learning, which may not be apparent even to the teachers themselves let alone others (Kerr, 1996). Significant number of studies on ICT in education have also reported that students extrinsic and intrinsic barriers affect their learning experience (Bingimlas, 2009; Ertmer, 1999; Khalid, Nyvang, & Islam, 2013). A framework for analyzing students' evaluation or learning experience mapping of a teaching session should include the barriers students and teachers state about an ICT-integrated teaching session.

Other studies conducted with a focus on frameworks based on student feedback include the following. Ozkan & Koseler (2009) developed a model to evaluate Learning Management Systems (LMS) in blended learning based 84 students' perception and analyzed quantitatively. The developed model can be utilized to identify social issues in the form of supportive factors, learner perspectives and instructor attitude, as well as technical issues in the form of system quality, content quality and service quality (Ozkan and Koseler, 2009). However, the model is not itself focused explicitly on students' learning experience. Focusing on the prerequisite factors to student course satisfaction, Denson, Loveday & Dalton (2010) found optional assessment questions for individual courses to be a better indicator of student satisfaction than mandatory questions used across institutions. Terry, Heitner, Miller & Hollis (2017) identified course assessment questions to be highly influential on general course assessment. The study also found that course content is a major determinant of both evaluation measurement and student assessment of the course. Similarly, Greimell-Fuhrmann & Geyer (2010) investigated student feedback quantitatively and qualitatively, chiefly finding teacher activity directed towards the subject-specific content to be the most important factor for general student assessment.

Despite the agreement in the academia that a student-centered approach should be the fundamental basis for the designs for learning and the evaluation of learning environment, there exists a lack of a theoretical framework for analyzing students' feedback. Students' learning goals and preferences vary, and teachers' teaching style and performance also vary. The integration and use of ICT and content in teaching are applied and perceived differently by teacher and students respectively. So, the goal of this study is to propose a preliminary theoretical framework by which students' experience of teaching sessions can be analyzed. The vision is to be able to automate the feedback process for each session by using a questionnaire and by computing the insights for continuous improvement of teaching-learning sessions. The theoretical framework is expected to contribute to the field of educational technology and more specifically to educational data science for learner experience design. To achieve the goal, this study collects and analyzes learners' feedback on ICT-mediated teaching sessions by applying concepts of motivation, perceived barriers related to the content, media, activity design, and teachers' interaction.

2. METHODOLOGY

Students' formative feedback after each of the six four-hour video-conferencing mediated and Moodle learning management systems (LMS) supported teaching sessions of a master level course of Danish university is collected. Using the 'feedback' activity of Moodle LMS, the students were asked to answer three open-ended questions at the end of each session. The formative assessment (Dixson & Worrell, 2016) questions were partially adapted from the 'exit ticket' on Google Forms. The three questions asked in the 'exit ticket' on Google Forms are 1. What's one important thing you learned in class today? 2. Did you feel prepared for today's lesson? Why or why not? 3. What would help make today's lesson more effective? The third question was adapted by appending some hints on possible

areas to state the feedback, i.e. (teacher's interaction, PowerPoint or other media design, instructions for activities or duration of activities, and learning content). General Data Protection Regulations (GDPR) is followed to define and apply ethical considerations. The participants are informed about the purpose of the study and the dataset used in this research is completely anonymized. Responding to the exit-ticket questionnaire was an optional activity and the students had to option to inform if their responses should be excluded from research.

Using the constructivist perspective, grounded theory (GT) was applied to analyze the data. There are several approaches to GT, but one stable definition is hard to find (Bryant & Charmaz, 2007). One of the main differences in opinion regarding GT is the subjective interpretations of researchers due to previous knowledge and the eventual construction of different analyses. For example, Thornberg states the following: "observation could never be totally free from theoretical influence because seeing is already a "theory-laden" undertaken" (2012, p. 246). Furthermore, "neither data nor theories are discovered, but are constructed by the researcher as a result of his or her interactions with the field and its participants" (Thornberg 2012, p. 248). In this GT, existing theories (applying known concepts, theories, and models of the fields and new literature reviews) unfold as follows:

- Going into the field without specific theoretical consciousness; the purpose is to explore and wonder.
- The first data analysis is performed without using existing theory extensively to focus on what the data say.
- The second data analysis applies the conscious use of existing theory to validate or criticize findings in the data.

Charmaz (2006) articulated GT analysis tools in a constructivist paradigm. Using Charmaz's guidelines for the coding process and initial coding, the data were reviewed line by line and then divided into themes or codes. Then open and axial coding was used, which formed the first set of categories and mapped the themes in a tabular form. The students' feedback on the different aspects of learning experience are tabulated as themes (or codes), sub-categories, and categories. The measurement dimension of the learning experiences as codes are then attribute with positive (+), negative (-) or undefined (u). For example, "the slides were a bit text-heavy today and should be reduced" was coded as 'slides presentation' and attributed with negative (-) sign.

Soon after the course, based on the first table of codes and categories, a survey questionnaire was developed and responded by the students from the same course (58 out of 70). The content of the survey included the students' learning experiences while using the LMS, the video conference system, subject matter of the course in question, and an open-ended question regarding other aspects for improving the teaching sessions. Based on students' feedback, scopes of improving teachers' interactions, technologies used, and considering students' learning preferences and background are identified. Based on literature review three motivational components (Montazemi, 2006) are considered as the point of departure for the mapping the codes. In addition, technical barriers, including video conference systems and teacher-related barriers (Jahromi et al., 2016; Unal and Unal, 2016) are identified as important items in mapping the codes. Furthermore, 'location and condition' emerged as a category that was not included in the barriers or motivational components. Lastly, the mapping of the codes into categories and the development of the proposed framework was reviewed using the feedback from three of six sessions.

3. RESULTS AND DISCUSSIONS

By analyzing students' feedback on teaching sessions, this section proposes a theoretical framework for formative evaluation and feedback to teachers. This framework takes the point of departure from the three motivational components described by Montazemi (2006) as follows: "(a) an expectancy

component, which includes the student's belief in his or her ability to perform a task (i.e., [computer] self-efficacy), (b) a value component, which includes the student's goals and beliefs about the importance and interest of the task (i.e., intrinsic value), and (c) an effective component, which includes the student's emotional reactions to the task (i.e., [computer] anxiety)." (Montazemi, 2006, p126). These components are based on a framework for mapping of student motivation, established by (Pintrich, 1989, 1988; Pintrich and De Groot, 1990). Besides, barriers are also included in the proposed framework based on students' response and barriers of e-learning implementation described by Jahromi et al. (2016).

The proposed framework is shown in Table 1, which categorizes the variables of students' feedback into the first column. The categories are made according to the three motivational components described by Montazemi (2006) and the barriers of e-learning implementation (Jahromi et al., 2016). So, the top-level categories are the reviewed motivational components and barriers. The sub-categories are used to specify what the students refer to, i.e. understanding, structure, video conferencing systems, and others. The last two categories 'Location and Physical Environment' and Suggestions" are entirely grounded as these cannot be traced in the existing literature. The right column shows the coding or statements like examples of the different variables of technology, pedagogy, and content of teaching sessions. The same code or variable can be mapped under all the three motivational components but refer to different underlying reasons. For instance, "slides presentation" being "text-heavy" and "image-heavy" can be identified as an issue if 1) a student 'believes' that the slide design affects "his or her ability to perform", or 2) a student does not value it as "important or interesting", or 3) it is a student's "emotional reaction" as it was covered too fast. So, the feedback given by the students' needs to be understood in such details and subjectively to take actions for improving the different variables or elements of teaching sessions.

For each of the variables or factors, students' feedback can be measured with an attribute, for example, positive (score 1), negative (-1), indifferent (score 0), and undefined or 'don't know' (score 0) when not responded. The summation of the overall score can be used to compute the overall score by category and per student. Computing the overall learner experience score by using Likert scale can be time-consuming and complex.

Table 1. Proposed Framework for Analyzing Students' Feedback on Teaching Sessions

Variables/Elements/Factors	Examples (Some of the values of the variables)
Self-efficacy (Expectancy component: Student's belief in his or her ability to perform the task)	
Understanding	
Teacher presentation	Speech tempo, language, body movement, eye contact
Slides presentation	Text-heavy, image-heavy
Previous knowledge	Had similar course before, have course as an interest
Co-teacher aid	Unknowledgeable/knowledgeable, poor/good at presenting
Reading materials	Too much, too little, too hard
Activity	Workshop, group work
Assignments	Written assignments
Structure	
Break	Too few, too many
Activity time	Not enough, too much
Lecture time	Not enough, too much

Sequence		Jumps back and forth between different activities
Course		Session info is hard to understand

Intrinsic value (Value component: student's goals and beliefs about the importance and interest of the task)

Usefulness		
	Teacher performance	Concrete information
	Slides design	Repetition, text heaviness, image-heavy
	Reading materials	Too hard, too easy, too repetitive
	Activities	Too hard, too easy, non-relatable to project
	Feedback	Useful for project, not useful for project
	Materials	Balls, Cards, Pens seem useless or useful
	Assignments	Written assignments seem useless or useful/relatable to project
Knowledge		
	Co-teacher aid	Unknowledgeable/knowledgeable, poor/good at presenting
	Student feedback (from teacher)	Feedback on course projects/activities
	Student feedback (student to student)	Feedback on course projects/activities
Structure		
	Break	Too few, too many
	Activity time	Not enough, too much
	Lecture Time	Not enough, too much
	Sequence	Too mixed structure making elements less useable
Reflection		Time to reflect on material and activities

Emotion (Effective component: Student's emotional reactions to the task)

Stress		
	Teacher performance	Talks too fast, covers too many topics
	Slides design	Too much text covered too fast
	Workshop task/activities	Too little time for activities, activities are on a timer
Structure		
	Break	Too few (stressful)
	Activity time	Too little time for activities, activities are on a timer
	Lecture Time	Too little time for the lecture, too much material
	Sequence	The structure is too mixed
Fun		

	Teacher presentation	Smiles, includes small physical exercises, humor
	Slides presentation	Funny pictures, humour
	Workshop task/activities	Humour, funny activities
Technological barriers		
Video conference system		
	Technical	Sound and vision good/bad, noise, lag, VCS makes communication difficult
Students' personal IT		Can't load documents, can't access websites, no/bad internet
Teacher barrier (Blended learning facilitator)		
Information accessibility		Difficult to access course information
Information amount		Too much, too little
Information structure		Poorly structured information
Location and Physical Environment		
Location		Good/bad Heat, Air, Space
Suggestions		
Suggestions for improved teaching sessions		Relating material clearer to final course assignment

Formative feedback on teaching sessions are sporadically conducted by some teachers and the analyses of the feedbacks are given very little time. The proposed framework can be used as a rubric for analyzing the students' formative feedback on technology-integrated face-to-face classes. Furthermore, both summative evaluation and formative evaluation of courses show that students give opposing statements for the same activity or content design. For instance, while some students criticize the different aspects of a lecture, others highly appreciate the same lecture. The proposed framework and the proposed scoring can be applied to compute the total positive score and negative scores to identify the pain points. The courses applying project-oriented and problem-based learning includes phases of difficulties and only parts of the content and activities covered in the course are applied in the project. So, a quick-and-dirty analysis of feedback will be misleading without the use of a framework (particularly for the three component of motivation). Learning activities include varying degree of hardship for the learners and might not always be assessed as we "learn only retrospectively" (Beista, 2011, p. 206).

4. CONCLUSIONS

In this study, a framework for the formative assessment of teaching sessions has been proposed by analyzing and categorizing students' feedback on video-conferencing mediated master level course's six four-hour sessions. The framework categorizes the student's experiences on ICT-integrated teaching sessions into variables or factors or elements and shows some examples by quoting students' feedback. The broad categories are: 1) self-efficacy (expectancy component of motivation), 2) intrinsic value (value component of motivation), 3) emotion (effective component of motivation), 4) technology barrier, 5) teacher-related barriers (blended learning facilitator), 6) location and physical environment, and 7) suggestions. The fifth category can be labelled as "ICT-integrated blended learning environment", which can be sub-divided according to information architecture and information systems test criteria. The "suggestions" can be applied as the "other" category. The exit-ticket questionnaire and the proposed framework can be adopted for pedagogical training and for

formative evaluation of teaching sessions in tertiary education. Due to the extensive use of motivation components for interpreting students learning, one might ask whether the units are analysis is a teaching session or a learning session. Students' feedback can be analyzed by mapping with students' persona using association rule mining for automating the formative assessment and developing recommender systems for teachers.

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