The Potentials of Automated Feedback Systems for Instructors in Higher Education

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Abstract: **Automated feedback systems have been associated with significant improvements in the outcomes for learners in higher education. The advantages for learners are well reported, but surprisingly few articles have investigated the advantages of automated feedback for instructors. This article reviews the use of feedback and automated feedback systems in higher education to assist instructors to self-assess and to privately identify potential improvements to their instructional practices. This article first describes how feedback is currently provided in higher education settings and then discusses requirements, technology, and innovations needed to create automated feedback systems for instructors. The proposed automated feedback system aims to assist university instructors by providing suggestions and feedback that could help to self-examine their work privately and immediately.**

Keywords: **Technologies Applied to Education, Feedback in Higher Education, Post-secondary Instructors, Automated Feedback Systems, Performance, Evaluation and Assessment.**

I. INTRODUCTION

Feedback can help people to exchange ideas and take actions using their knowledge, experiences, and the level of understanding about a specific action or input (1; 2). Feedback can influence recipients to change their actions in response to the feedback (3). Feedback can be defined as the information provided to someone about a certain action or performance (3; 4; 5). Feedback is often generated by a human instructor or tutor; however, feedback can also be provided automatically using computer systems (6; 3). Feedback is a powerful and effective tool to provide information to educators and students (1; 2).

In higher education, providing immediate or delayed feedback can impact the learning process (7; 8; 9). Feedback is mostly generated by a human instructor to assist students on their learning tasks (7). However, feedback can be also provided automatically using computer systems. Computerized learning systems can provide automated feedback to help students without human involvement (10; 11; 12; 13). Intelligent Tutoring Systems are an example of the computerized learning systems which can help students to complete or improve their learning tasks automatically (14; 15; 1). These automated feedback systems can facilitate students learning by providing feedback about their learning activities automatically.

The goal of this review article is to study how feedback is delivered to postsecondary educators. It addresses the following two research questions: "How is feedback given to post-secondary instructors?" and "Is there potential for automated feedback to be helpful for post-secondary instructors?". To accomplish these goals, we first explore definitions of feedback in higher education as well as how feedback is provided to students and instructors. The types of feedback are grouped into distinct categories each with advantages and disadvantages. Automated feedback systems and how they can benefit learners and instructors are explored in the final review section. The article concludes with a research vision of viable automated feedback systems to benefit post-secondary instructors.

II. FEEDBACK IN HIGHER EDUCATION

In post-secondary education, feedback is important for educators, learners, researchers, and administrators (5; 14; 15). Educators can provide feedback about students' activities and learning processes so that learners can improve their performances. Students can provide feedback to instructors using the end of the semester evaluations which can provide information about course content as well as instructors' performances (25; 26). Administrators can also use students supplied feedback to make decisions about new educational initiatives, the effectiveness of prior decisions, evaluating a specific program, or writing reports. (27; 28).

Feedback can be delayed or immediate that are provided to students and instructors. The sooner feedback is produced the better results will be achieved (6). Immediate feedback can be used to improve educational processes than now often rely on delayed feedback (3; 6). In particular, the processes of providing feedback to instructors may be greatly improved if immediate feedback processes are employed Automatically.

Automated feedback systems refer to any system that uses some data to generate information intended to be delivered to a specific user (23; 29). Automated feedback can also be defined as feedback provided right after a specific task or action is done or after automated feedback systems produced outcomes about specific inputs (23; 27; 6). In higher education, providing automated feedback can assist recipients to make better actions or changes about their learning tasks and produce more quality outcomes (7; 3; 6). For example, using grammar checker systems can assist students to receive automated feedback about their writing. This feedback could help to correct grammar and spelling mistakes without human involvement. Also, it can help to change particular words and select better choices that can enhance students' writing tasks.

Feedback for Students

Feedback is an essential part of the teaching and learning process that can help students in their educational activities (30; 7; 15). The feedback provided to students can produce comments and useful information that show improvement and achievement. Those feedback can help to measure students' works by comparing the current instructional situation with desired objectives in that specific instructional environment (14; 30; 5). This feedback is mostly used to provide information to learners and their abilities about some coursework activities and assignments' results (7; 3). The feedback is generally occurred after students finish their educational tasks whether the feedback is delayed or immediate (4; 15).

Delayed Feedback for Students

Students can receive feedback that is generally provided by instructors about their learning tasks (26; 5). The normal interaction-feedback cycle happens when an instructor asks students to work on a task and waits for them to complete it. Then, the instructor evaluates the work the students have done and provide feedback about students' outcomes (30; 5). Providing feedback to students can help address what issues, mistakes, or what parts need to improve (27; 18; 29). For example, when an instructor assigns some homework to students, they can work on that homework until they submit it. The instructor will review each student's work. Then, the instructor can provide feedback to students about their homework results.

Another way of providing delayed feedback to students is using peers' feedback (26; 5). Classmates can help each other to work on learning activities and then provide feedback to each other (31; 32). Students can evaluate and provide feedback to peers about different learning tasks they work on as teams or even about individual activities (33; 34; 35). Students can follow predefined criteria provided by their instructor and use their knowledge and experience to evaluate their group members and provide feedback (5; 31). Peers intend to provide useful feedback to their teammates so then can make better outcomes, so the evaluation results are incorporated into the final grade (31).

Delayed feedback to students can also be provided using computer-aided systems (1; 28). There are many automated feedback systems that produce feedback about learning tasks like sending students test away to be scored and waiting for the results (1; 28; 36). The feedback will be in a form of students' grades that will be given to students sometimes in the future. In this article we are only considering automated feedback systems that provide immediate feedback.

Immediate Feedback for Students

Immediate feedback can be provided by instructors and automated feedback systems (16; 13). Instructors can provide immediate feedback about students' activities by watching students working on their learning tasks and then providing feedback (3). Automated feedback systems can provide immediate help to students in more convenient time without the

need to wait for instructors to watch them working on that learning tasks (6; 36; 37). These automated systems can simply provide feedback to a specific task like assignment confirmation after students' submission or what grade they make (26; 13). Also, those automated feedback systems can provide complex information with more details including real-time feedback that can provide auto corrector and steps to improve their works (7; 14).

Automated feedback can improve students' performance by motivating them to be engaged in the learning process (3; 4; 38). Students can work on different learning activities and receive timely feedback after each step (7; 16; 39). Those steps can assist students to improve their learning and make better results. There are many automated systems and online educational platforms that can help students to receive feedback immediately (39; 30). Intelligent Tutoring Systems (ITS) and Massive Open Online Courses (MOOCs) are commonly used for supporting students and to automatically evaluate their assignments and provide feedback to their activities (40; 41; 42; 13). Grade-Mark is another online marking modules that can review the students' work to show any plagiarism detection. The quality and accuracy of those automated feedback are high quality and have almost the same positive results as human feedback (26; 16; 14).

Feedback for Instructors

Feedback provided to instructors is usually described as information about students such as class averages or drop fail rates (43; 44). Instructors mostly receive objective feedback about students' performance and class learning activities (43; 45). Feedback can also provide information to instructors that can make them aware about learning process like what issues related to class activities and if there are any missing pieces in class materials (23; 3; 18). This feedback can help instructors to take the appropriate proactive actions about specific situations such as to provide more help to students who are not doing well (44; 30).

In general, feedback delivered to instructors can be a type of subjective evaluations to provide information that may help instructors in the future (46; 43). The feedback can be a summary report after the class concluded that show students' performance, success rate, grades, etc. Students can use end of semester evaluations to provide feedback and evaluate instructors (47; 46). The outcomes of those evaluations can be used by experts, administrators, or experienced instructors to assess and provide feedback to the class instructor (47; 30). Those feedback intend to produce information to help instructors to make any changes they need regarding the learning process.

Delayed Feedback for Instructors

Delayed feedback can be produced to instructors by peers or colleagues, administrators, students, and computer systems (7; 29; 48). Peers and colleagues can use observation methods to assess instructors and then provide feedback using their experiences, knowledge, and skills (29; 32; 43). They can also use video recordings and review learning activities to provide late feedback to instructors (7; 31; 49). Students can evaluate and provide feedback to instructors using evaluation forms at the end of the instructional units (46; 24). Experts and administrators can use those evaluations and students' feedback to be used to assess and provide late feedback to instructors (14; 33). Instructors can also use computer systems that provide information about the learning process like students' grading, weekly summary, failing rates, etc. (29; 7).

Using evaluation forms that happen at the end of each semester is an important way to understand the required improvements (38; 50; 2). Instructors typically receive late feedback from students using end of the semester evaluations (14; 46; 15). It is the most common but often ineffective mechanism for providing feedback to instructors (51; 52). The late feedback results from this method can help instructors to compare the actual learning outcomes with the designed objectives (26; 50). The feedback is usually a written subjective report that shows what areas where instructors are lacking or need improvements. However, this feedback can inform and support instructors after evaluating course materials to help to improve students' learning activities and outcomes (14; 15; 7).

Automated feedback systems can also provide delayed feedback to instructors (26; 7; 29). Those computer systems can show students' performance, timelines, class summary, etc. (21; 20; 1) For example, instructors can use computer systems to check the total number of students who submitted their assignment on time, late submission, and who did not submit. Instructors can benefit from using those automated systems to save time checking students' works. For instance, instructors can use Turnitin to check if students have any plagiarism or academic misconduct issues. Turnitin is a common automated feedback systems that can check if students' works are original and highlight any potential plagiarism issues (26; 14). The feedback coming out of Turnitin is a type of late report that instructors can use to evaluate students and provide the needed feedback.

Immediate Feedback for Instructors

There are few studies that investigated providing immediate feedback to instructors (14; 15; 1). Immediate feedback is produced automatically right after finishing the learning task (6; 1; 30). Most of those automated feedback systems and online systems can provide feedback about students' learning activities (13; 42). Instructors may benefit from using the feedback outcomes to assist them to have a clear idea about students' performance. This can assist instructors directly to track students' activities and mistakes and then provide the needed help to address those issues. For example, when using online learning systems, instructors can receive immediate feedback from students about whether they understand the material or not. Then, the instructor can provide the suitable help to students.

III.   DISCUSSION

Providing feedback and automated feedback can offer advantages to students and instructors in post-secondary education (16; 14; 26). The feedback can be delayed and immediate depending on the recipients' needs. The feedback will include an action, type of delivery, and components of feedback. Timely feedback can provide actionable information to higher education students and instructors. However, most of the existed methods of providing human and automated feedback aim to serve students in one way or another. The outcomes from the computerized learning systems like auto-graders, grammar checkers, etc. can facilitate learning tasks and provide useful information to students (26; 20; 23).

Research to explore automated feedback systems for instructors' advantage has not received the same amount of attention. This might be a result of the complicated and unclear ways to evaluate instructors' performances and the possibility that automated feedback for instructors could be used for evaluation by institutions instead of for information to be used by the individuals. Students can be easily evaluated using their learning activities outcomes to be compared with predefined standards or rules. This way will help to provide the required feedback whether the feedback is delayed or immediate. However, in the instructor's case, it is not an easy process to set standards and rules for instructors to follow when working in their learning activities. This makes it harder to design an automated feedback system that provide feedback for instructors' benefits.

Using the end of semester evaluations has been used for decades to evaluate and provide feedback about class instructors and course materials. This method has shown good advantages in higher education especially providing late feedback for instructors. However, this method requires time, knowledge, and skills from the evaluators (43; 7; 24). Also, there are few issues related to the end of the semester evaluation such as students' honesty and how effectively those evaluations could measure the quality of courses. Those kinds of evaluations are only beneficial if students are honest when they do the evaluations and student honesty cannot easily be measured (53; 51). Also, the end of the semester evaluations is a type of summative and subjective measurement instead of formative and ongoing fair evaluations (52). In fact, providing feedback for instructors is a very complex process (51; 53; 52).

In higher education, instructors are normally measured by their scholarly outputs because it is quantifiable but there is no complete way that can measure instructors' success (51). Researchers claimed that providing immediate feedback to instructors is a new and interesting area of research (47; 46; 42). They mentioned that providing feedback to support instructors' needs is a good way to improve course contents and instructional approaches that will result to enhance the learning process (28; 54; 39). Other studies claimed that using feedback can help to improve faculty performance, and they showed that feedback analysis is important to help educators to make better developments in classes (27; 19).

Designing automated feedback systems for serving instructors can be a challenge and a complex task because of the different types of feedback and objectives (1; 29). The feedback is mostly used to identify mistakes which can help students to realize their errors, but instructors cannot easily adapt this way of feedback to their own advantages (20). This is because feedback provided to students can be evaluated and examined easier using their outcomes (55). Evaluating instructors' feedback is a challenging task. Studies showed that instructors' performance can be evaluated using examiners, peers' reviews, or self-assessment (55). However, there are few studies investigated how instructors' performance could be assessed. Most advantages of using automated feedback for instructors have been mostly drawn from a limited number of studies focusing only on online courses' platforms (5; 7; 51).

IV.   THE POTENTIALS OF AUTOMATED FEEDBACK SYSTEMS FOR INSTRUCTORS

Providing instructors with timely feedback can allow them to make changes to their practices. This immediate feedback can also facilitate the process of self-improvement and instructional change. The feedback produced automatically could show information to instructors about specific learning activities. For example, when instructors receive many emails

from students, automated feedback systems could help to detect students' common issues using the questions that students ask and then provide a summary to the class instructor about students who need help and what concerns they have. The feedback could help instructors to be aware of what they need to address and give more concerns without any human involvement. Also, the feedback would be in a timely manner so there is no need to wait until other people provide those feedback.

Developing automated feedback systems that aim to provide immediate feedback to instructors could be done using data mining applied to instructional outputs (38; 56; 45). There is a lot of data available to help instructors to understand how their courses are going including course planning documents, grades, emails, discussion forums, assignment grading notes, quiz scores, lecture attendance, etc. Data mining can use those information resource to provide immediate feedback to instructors (28; 47; 54). Data mining tools and techniques can provide and predict information like detecting students who need help, preventing students from dropping out, predict learning performance, etc. (57; 58; 59). In addition, data mining techniques can be used to help discovering useful information about formative and summative evaluations and can also assist people to evaluate themselves (59; 21).

Automated feedback systems can offer many benefits to instructors by producing feedback right after they finish their learning tasks. The automated feedback system can use instructional outcomes like course preparation, course outlines, course websites, assignments, lab descriptions, etc. as the data inputs to be processed and then provide feedback to instructors as the system outputs as shown in Figure 1. The Automated feedback systems for instructors could provide immediate feedback to instructors about teaching methods, skills, missing requirements, summary reports, and self-assessment.
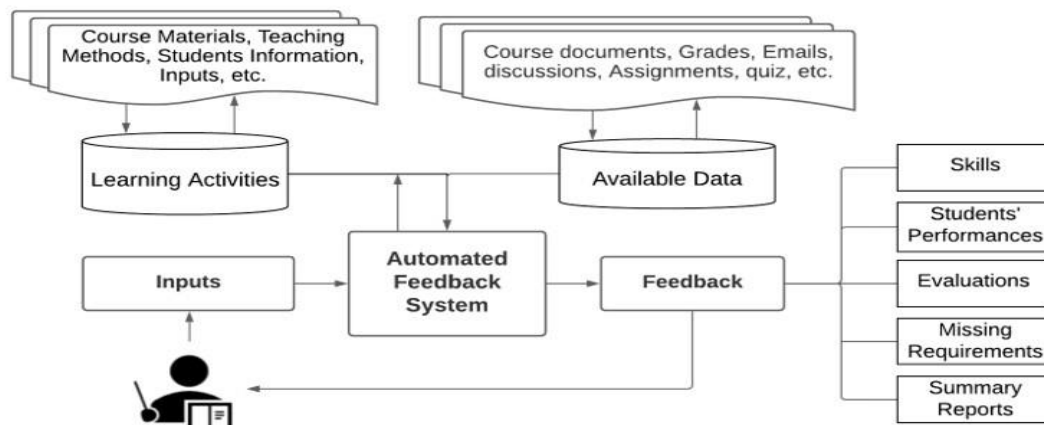

Figure 1: Automated Feedback System

This article shows the possibilities of identifying a framework that can provide automated and immediate feedback to university instructors. The framework aims to help instructors to self-assess some parts of the learning process by using data mining techniques applied to various post-secondary instructions' outputs. These instructions outcomes like course materials, chat logs, student questions, emails, assignment descriptions, etc. can be used to be the inputs for the framework to be processed automatically and then produce useful outputs. The feedback resulting from the framework could assist instructors to raise awareness of what part are missing of the learning process. Also, it could facilitate instructors to self-assess their performance immediately. Measuring the outcomes of the framework could be done by comparing the automated feedback outputs with human feedback to ensure accuracy and quality of the framework.

V. CONCLUSION

In conclusion, this article describes how feedback is produced in higher education to learners and educators. The feedback provided to students are mainly generated by instructors or automated feedback systems. The feedback provided to instructors are generated by students, peers, and administrators. Review of existing literature showed that limited works have been done regarding the automated feedback to instructors. Instead, many studies showed how instructors receive human or delayed feedback using students' evaluations, self-evaluations, peers' observations, videotape recording and reviewing, and staff supervisor consultation.

Feedback provided to instructors is often delayed which prevents them from acting on the feedback in a timely fashion. In the big data era, there are some disadvantages of using delayed or human feedback. So, there is a need to explore a faster and effective way of providing feedback. Using automated feedback systems might be a solution to provide timely suggestions and useful information that could help instructors in a timely manner. Universities instructors will get good advantages from exploring and adopting more automated feedback systems.

We propose a framework that can provide feedback to instructors automatically. The automated feedback systems for instructors are possible when the required data, measurements, standards, and evaluation tools are identified and understood. Those findings will help to improve the overall learning processes thus improving the educational objectives and quality of learning and outcomes.

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