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SHORT REPORT

Audience response systems as an interim measure of quality using Bloom's taxonomy of learning outcomes

Asim Ahmed Elnour[1,2]

[1] Program of Clinical Pharmacy, College of Pharmacy, Abu Dhabi Campus Al Ain University, Abu Dhabi, United Arab Emirates
[2] AAU Health and Biomedical Research Center, Al Ain University, Abu Dhabi, United Arab Emirates

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Correspondence
Asim Ahmed Elnour
Program of Clinical Pharmacy
College of Pharmacy
Al Ain University
Abu Dhabi
asim.ahmed@aau.ac.ae

Abstract

Learning methods are transforming with the help of modern technology. The availability of versatile innovative technologies such as the audience response systems may assist in the transformation of learning and training methods in pharmacy education and consequently, increase student engagement and promote active learning. This review emphasises the audience response system as an assessment tool that can be emulated by pharmacy instructors. It can be implemented in the daily learning process to foster the wide engagement of students in the learning process. Furthermore, the shift in pharmacy education due to COVID-19 and the upsurge of online tools support the innovative role of audience response systems. The audience response system suits numerous interactive classroom purposes. A new generation of pharmacy students' transformational roles, future responsibilities, and emerging patient and societal needs dictate the need for interactive learning styles that encompasses the use of the current audience response system and other appropriate approved tools. The audience response system needs to be mapped with a revised version of Bloom's taxonomy to ensure the learning outcomes are achieved in appropriate levels.

Introduction

Student learning methods are transforming from traditional lecturing models to interactive learning with modern technology and the speed of life in the 21st century. The availability of versatile, innovative technologies such as the audience response systems (ARS) may assist in the transformation of learning and training methods in pharmacy education and consequently surge student engagement and promote active learning (Kay and LeSage, 2009).

The historical perspective for ARS

The ARS has been defined as tools used to promptly assemble data from people participating in a poll/opinion or poll/survey. The ARS were dated back to the 1960s at Cornell and Stanford Universities (Nelson, C. *et al*., 2012). Historically there were several synonyms for audience response systems (ARS), such as classroom response system, electronic voting system, personal response system, or student response system, (Kay and LeSage, 2009). The current evolution of ARS has brought improved technologies with ease of accessibility (accessible by smartphone, tablet or computer), handling, PowerPoint mounted software, statistical outputs, mobility and enhanced outputs suitable for diverse educational settings (Cain, J. *et al*., 2009; Kay and LeSage, 2009).

The pros and cons of ARS

ARS is an automated system formative assessment approach that delivers to the instructors and student's prompted feedback, enhanced understanding, communication and interaction through debriefing on item answers, (Divall, M.V. *et al*., 2014) and statistical outputs for responses in an interactive screen displayed fashion. The ARS can be used in versatile settings such as in education, professional skills training, seminars and conferences. In pharmacy education, ARS has been adopted in various courses and curriculums (Stewart, D.W. *et al*., 2011).

It has been well reported that ARS improves the efficiency of didactic lectures via enhancing the classroom attendance of students, attention levels, motivation, engagement (participation, connection, interaction), helps reduce communication apprehension, stimulates peer and class discussion, increases learning, provides feedback mutually for students and instructors in order to progress instruction and learning performance (Slain, D. *et al*., 2004; Caldwell, J.E. 2007; Liu, F.C. *et al*., 2010; Kevin, A. *et al*., 2012; El-Rady, J. 2019).

The ARS and the Bloom's taxonomy

The original Bloom's taxonomy, which is the taxonomy of cognitive objectives, was developed in the 1950s by Benjamin Bloom. It represents a means of expressing qualitatively different kinds of thinking. It has been adapted for use in classrooms as a planning tool. The tool is universally accepted whereby it provides a method to organise thinking skills into six levels (Evaluation; Synthesis; Analysis; Application; Comprehension; and Knowledge) from the most basic to the more complex levels of thinking (Anderson, L.W. *et al*., 2001).

The original version of Bloom's taxonomy was revised by a former student of Bloom (Lorin Anderson) in the 1990s (see Table I and Figure 1). The revised Bloom's taxonomy (RBT) major six levels items of thinking skills correspond in order to the original version (Evaluating; Creating; Analysing; Applying; Understanding; and Remembering), i.e. were changed from noun to verb forms (thinking is an active process verbs were used rather than nouns). For instance, the word "*knowledge*" in the original version was replaced with the word "*remembering*" instead of in the RBT. The revised RBT deploys the use of 25 verbs that create a collegial understanding of student behaviour and learning outcome.

Table I: Original Bloom's Taxonomy (1956) and the Revised version 2001 (RBT)

Bloom's taxonomy (grounded by learning objectives)	**Revised Bloom's taxonomy (RBT revised terms) (grounded by taxonomy for teaching, learning, and assessment)**
Evaluation	Evaluating: Checking, Critiquing
Synthesis	Creating: Generating, Planning, Producing
Analysis	Analysing: Differentiating, Organising, Attributing
Application	Applying: Executing, Implementing
Comprehension	Understanding: (Interpreting, Exemplifying, Classifying, Summarising, Inferring, Comparing, Explaining)
Knowledge	Remembering: recognising, recalling

Note: The revised Bloom's Taxonomy (2001) uses verbs and gerunds to label categories and subcategories (as opposed to the nouns used in the original taxonomy (1956)). The "*action words*" in the revised Bloom's Taxonomy describe the cognitive processes by which thinkers/students/teachers encounter and work with knowledge.

The author explored Bloom's taxonomy and the RBT in ARS in an attempt to strengthen the use and benefits of ARS for better learning outcomes. The author has applied the RBT on the ARS tool to improve the proposed assignment of the levels of RBT to the ARS, as illustrated in Table II.

Table II: The benefits of ARS and possible corresponding Bloom's taxonomy and matched revised Bloom's taxonomy

ARS feature benefit	**Bloom's Taxonomy**	**Revised Bloom's Taxonomy (RBT revised terms)**
It can be anonymous or not, which encourages students to participate	Synthesis	Creating
Provides real-time feedback and assess the understanding of your students	Analysis Comprehension	Analysing Understanding
Allow competition which stimulates your students.	Synthesis	Creating
Permit more interaction with your students which will make remembering easier	Knowledge	Remembering
Create fun and spices up your in class learning	Synthesis	Creating
Perform student evaluation and show students their progress	Application	Applying
The questions can be directly integrated into instructor presentation	Application	Applying
The audience can vote by computer, smartphone or text so that no-one is left out	Evaluation	Evaluating

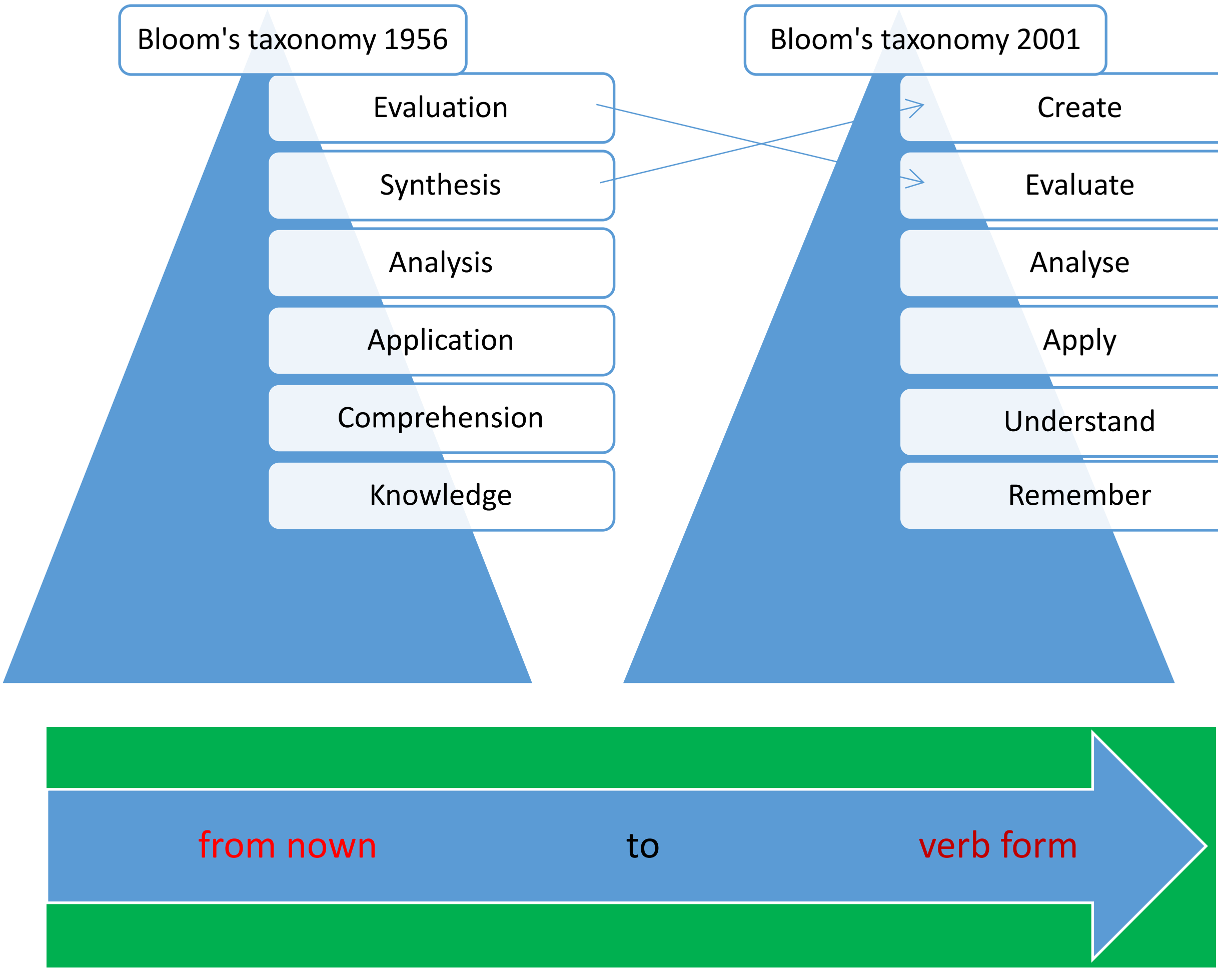

Figure 1: Original Bloom's Taxonomy (1956) and the Revised Bloom's Taxonomy (RBT) version 2001

Discussion

This review emphasises the ARS as an assessment tool that can be emulated by pharmacy instructors and implemented in the daily learning process to foster the wide engagement of the student in the learning process whereby the students' challenges application of such technology to critical thinking, problem-solving, reflective practising, sustained quality learning, evaluation of respective learning and peer-peer assessment.

The shift in pharmacy education due to COVID-19 and the upsurge of online tools support the innovative role of audience response systems. The current ongoing Covid-19 pandemic has resulted in a paradigm shift in global pharmacy education. Therefore, pharmacy educators are challenged with enormous changes that need to be resolved in virtual learning. The ARS may assist in maintaining the quality of learning, improving the virtual learning process and advancing pharmacy education. A small study has reported that students suggested that Kahoot (ARS) can be used to overcome the challenges of virtual learning during the COVID-19 pandemic (Yu *et al*., 2021).

The recently published report of the American Association of Colleges of Pharmacies (AACP) clearly stated that colleges and schools of pharmacies across the United States had shown great interest in continuing active learning strategies and team-based learning for students (Bzowyckyj *et al*., 2021). Many systematic reviews of studies have evaluated the use of ARS in pharmacy education during covid-19 with favourable results (Hussain *et al*., 2019a; Kocak, 2021).

Therefore, it is prudent to say that the use of ARS is highly beneficial in undergraduate as well as postgraduate curriculum. The mutual benefits arch both students and instructors enable enhanced communications with a directed emphasis on student's attendance, attention, participation (particularly for some students reluctant to participate in formal in-class learning) feedback, evaluate understanding, and overcome haslets in understanding (for weak students) and draw the attraction of students (Trapskin *et al*., 2005; Flora *et al*., 2010). In a survey of students, faculty and administrators from six pharmacy colleges across the United States, examining the use of the recent technologies (including ARS) in the classroom, a high satisfaction was reported for the appropriateness of such technology (Margarita *et al.,* 2013).

In 2016, a meta-analysis of the effects of audience response systems (clicker-based technologies) on cognition and affect reported significant effects of using ARS-based technologies on desirable cognitive and non-cognitive learning outcomes with significant implications for the implementation of clicker-based technologies in the classroom (Hunsu *et al*., 2016). A recent systematic review (2019) reported the benefits of ARS as a tool for effective learning (Hussain and Wilby 2019b). This meta-analysis reported positive findings from the Spain study (using ARS Spain version) in first year pharmacy students (Fernández-Alemán *et al*., 2016). The Netherland study reported complex interaction between the student learning and attitudes toward student response system interactive learning technology (Galal *et al*., 2015).

Types of ARS

There are numerous types of ARS, such as OMBEA, Kahoot, QuizTimw, Sli-do. Socrative, SunVote, Ubievent, Wooclap. One study reported more active participation of students (Gurascio *et al*., 2017) and clinical case-based learning for Socrative (Bright *et al*., 2013). The differences aligned between those technologies tool relies on: ease of use, ease of setup, ease of admin, quality support, ease of doing business, user satisfaction, performance analytics, questions types, feedback to the instructor, and meeting your requirement. The choice of ARS to be used will depend on available resources, students' perceptions and the assessment outcome. Furthermore, use in undergraduate, the ARS is gaining momentum in pharmacy continuing education (Peter *et al*., 2018) as in running conferences and events.

The growing adoption of accreditation standards (e.g. Accreditation Council for Pharmacy Education (ACPE)) in higher education with the mandate of attainment of educational outcomes (Accreditation Council for Pharmacy Education, 2016) dictates the need to specifically test ARS with criterion testing assessment as an assessment tool on the desired fulfilment of student learning outcomes on a versatile doctor of pharmacy (Pharm. D.) syllabuses and curriculum. The value of such an approach has been described as best practice and was recommended by pharmacy assessment leaders (Williams *et al*., 2011).

The data generated from ARS can be analysed by demographic, sub-groups, responses tracking and performance for prompted assessment. This feature can be used to convert the generated collated data in the long-term for research purposes. It remains to be investigated in future research to enable maximum benefits of the ARS student learning environment. Nevertheless, the faculty and instructors can conduct mentorship and academic advising based on-screen report from ARS and demonstrates such graphical report to meet certain students' improved performance and target achievements. Further, the ARS can be used by the academic administrators to track the student's performances and collate initial, the student's performances and collate initial, mid and final reports (Koval, 2020; Iqbal, S. *et al*., 2021).

Formative assessments are difficult to do; however, ARS resembles an option for an easy way to conduct them. Formative assessments are now increasingly required by accreditation bodies and as an interim measure of educational effectiveness (quality). Creating assessments using Bloom's taxonomy is essential to have learning happen at the right level (e.g., year one low, year three medium and year five high level of Bloom's mostly). Using this suggestion is important to position ARS at the right level to avoid causing a mismatch in learning-assessment competency.

The challenges of new technology to current pharmacy education will continue to rise with the high rhythm of synchronised mobile devices, virtual, artificial intelligence and 3D dimensional models invading the in-class learning environment. The race will continue in high turnover; therefore, more efforts are deemed by the researchers in pharmacy education to keep the pace with innovative learning technologies. Future studies are needed to reflect the benefits of the ARS tools in respondent satisfaction, improving assessment outcomes and maintaining the academic performance of students.

Conclusion

The use of ARS is evolving in pharmacy education, particularly in developed countries (USA and Canada) and some developing countries. The evidence for the benefits of ARS is growing with the reported impact of ARS on the student's learning outcomes. The ARS suits numerous interactive classroom purposes. The ARS need to be mapped with RBT for improved student learning outcomes. The new generation of pharmacy students' transformational roles, future responsibilities and emerging patients and societal needs dictate the need for interactive learning styles that encompasses the use of current ARS and other appropriate approved tools.

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