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Experiences of tertiary EEE programs in Bangladesh to address the Washington Accord Graduate Attributes in the affective learning domain

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ABSTRACT

CONTEXT

The Board of Accreditation for Engineering and Technology (BAETE) in Bangladesh has begun outcomes-based accreditation (OBA) of engineering programs since 2017. The BAETE stipulated graduate attributes (GA) are identical to those of the Washington Accord (WA). Outcomes-based education (OBE) is a new paradigm in Bangladesh, which many programs find difficult adapting.

PURPOSE OR GOAL

Traditionally the engineering programs in Bangladesh have not given much emphasis on developing the right attitudes of the graduates, focusing more on the hard technical aspects. Therefore, it is a challenge for many programs to duly address a number of BAETE GAs related to the appropriate attitudes and behavioural aspects of the graduates. The goal of this study is to explore the major challenges that EEE tertiary engineering programs in Bangladesh face to duly support students to attain these GAs and to identify suitable solutions.

APPROACH OR METHODOLOGY/METHODS

Three tertiary EEE programs have been selected under one of the following categories: (a) successfully accredited, (b) unsuccessful in getting accredited, (c) not yet applied for accreditation. A mixed-methods approach containing open-ended in-depth interviews and questionaries has been followed to tap the experiences of the concerned academics regarding addressing the relevant GAs. Focus group discussions (FGDs) have also been arranged with key persons of selected programs. Challenges and solutions are identified and analysed accordingly.

ACTUAL OR ANTICIPATED OUTCOMES

The major challenges faced by tertiary EEE programs in Bangladesh on the GAs related to graduate attitudes have been identified. The solutions to these challenges are also identified. General trends or patterns in the challenges and the solutions are highlighted.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

Different countries have different challenges and solutions to address GAs related to graduate attitudes. Challenges for Bangladeshi engineering programs and their solutions are summarized to address these GAs. It is pointed out how these experiences can be relevant for other programs and researchers.

KEYWORDS

Adapting to outcomes-based education and accreditation, Graduate attributes related to affective domain, challenges in curriculum design.

Introduction

Board of Accreditation for Engineering and Technical Education (BAETE), an independent accreditation agency under the umbrella of the Institute of Engineers, Bangladesh (IEB) has been accrediting tertiary engineering programs in Bangladesh since 2003 (BAETE, 2023). BAETE is a provisional signatory of the Washington Accord (Washington Accord, 2023). BAETE introduced outcomes-based accreditation (OBA) in 2017. The Program Outcomes (PO) stipulated by BAETE are identical to the graduate attributes (GA) of the Washington Accord (IEA 2013). These are given in Appendix A. The POs can be broadly classified into three categories: PO(a) – PO(e) represent attributes related to analysis of engineering problems and synthesis of solutions, individual responsibilities of engineering practice and practitioners are addressed through PO(f) – PO(h) and attributes related to workplace are PO(i) – PO(l) (Liew and Kiew, 2022). While the learnings to attain the POs related to analysis of problems and synthesis of solutions primarily belong to the cognitive domain of the Bloom's taxonomy (Bloom et al, 1956) or the psychomotor domain, other POs require significant learning in the affective domain.

Before 2017, all the tertiary engineering programs in Bangladesh were following the input-based academic paradigm focusing mainly on the technical aspects of engineering. There was little or no emphasis in the curriculum to develop the right values and attitudes of the graduates by appropriately conducting teaching-learning-assessment (TLA) in the affective domain. These programs began adapting to outcomes-based education (OBE) in response to BAETE starting to practice OBA in 2017. They have struggled to transform their education from input-based to outcomes-based facing many challenges. The problem was particularly acute with regards to addressing the POs in the affective domain. This observation reconfirms the assertion that the affective domain is the most ignored of all three learning domains of the Blooms taxonomy (Pierre & Oughton, 2007, Shephard, 2008). As a consequence, curriculum design and TLA in the affective domain remains as one of the most serious hurdles to the transformation to OBE.

Overcoming the challenges of embedding POs (or GAs) in the curriculum and implementing suitable pedagogy models requires innovative TLA approaches (Finkel, 2013). Various challenges and the corresponding innovative solutions in different countries have been reported in the literature (Kandakatla et al, 2023, Steenkamp & Tartibu, 2020, Manzoor et al, 2017, Keong et al, 2020). In certain cases, even more than a decade after a program is in place and the relevant accrediting agency practicing OBA for several years, challenges persist (Liew and Kiew, 2022). A review of the literature also reveals that the challenges are greater with the POs belonging to categories of individual responsibilities and workplace, where TLA in the affective domain plays a more important role.

No study has yet been reported on the experiences of the tertiary engineering programs in Bangladesh in transforming the education from input-based to outcomes-based. While informal discussions with the relevant academicians in this country indicate that not unlike in other countries, their challenges too are more serious when attainment of POs by the graduates in the affective domain are concerned, there is no evidence-based demonstration of this observation. Although the POs (GAs) stipulated by the Washington Accord and BAETE are generic and apply to all engineering disciplines, the challenges and the solutions may vary from discipline to discipline.

Against this backdrop, the objective of this limited scale study is to find out the challenges tertiary Electrical and Electronic Engineering (EEE) programs in Bangladesh face to ensure that the BAETE stipulated POs are meaningfully attained by the graduates in the affective domain. In particular, our focus will be on the attainment of PO(f), PO(g), PO(h), PO(i) and PO(l). These POs are primarily concerned with assessing societal and environmental issues and committing to professional ethics relevant to engineering practice, functioning effectively in diverse teams, and preparing for lifelong learning. Possible ways to overcome the challenges will also be explored. Detailed findings of this study involving more respondents, more data and more elaborate analysis will be reported elsewhere.

Methodology

One tertiary EEE program was purposefully selected under each of the three categories as indicated in Table 1. The two selection criteria applied were as follows: (1) the program is at least 10 years old, and (2) the program follows OBE. The concerned Dean/Head/Coordinator of each program was requested to nominate a number of faculty members from the program who have been playing leading roles in designing and implementing the OBE system. The nominated faculty members served as key informants in this study. The number of respondents from each program is also shown in Table 1. The total number of respondents (*n*) is 13. Although many BAETE (and Washington Accord) stipulated POs require learning in the affective domain, the focus of this study is limited to five POs, namely, PO(f), PO(g), PO(h), PO(i) and PO(l). A mixed-methods approach (Borrego et al, 2009) was adopted for this study. All the respondents were requested to fill out a questionnaire. Questions required numerical responses as well as open-ended qualitative responses. Numerical responses were collected using a 5-point Likert Scale (1 – least desirable, 5 – most desirable) (Likert, 1932). Focus group discussion (FGD) was arranged separately with the respondents from each program. All respondents attended the corresponding FGD. FGDs were arranged both in the face-to- face and the online modes. Seven exploration questions were discussed in every FGD. These questions are given in Appendix B. In addition, respondents were also encouraged to discuss about any other challenges that they thought important. The curriculum of each program was also reviewed.

Table 1: Selection of programs and respondents

Program	Category	Number of respondents
Program A	Accredited by BAETE recently	6
Program B	Failed to be accredited by BAETE recently	5
Program C	Yet to apply to BAETE for accreditation	2

Results and Discussions

All three programs have been practicing OBE for at least two years. It was confirmed by the respondents in FGDs that before the transformation to OBE, each curriculum was input-based with 70-80% technical contents. Around 75% of the learning was in the cognitive domain and the rest was in the psychomotor domain. The curriculum did not include any learning component in the affective domain. After implementation of OBE, the relative weight of the technical contents was reduced to 60-65% without any significant reduction in the contents. The volume of learning activities that the students would have to do under OBE to graduate from the program was thus substantially increased. After the transformation, around 60% of the learning falls into the cognitive domain and 20-25% into the psychomotor domain. Affective domain learning, newly added, now covers around 15-20% of learning.

Responses to the questionnaire

Mean value of the numerical responses of the three programs to the questionnaire is presented in Figure 1. Table 2 shows the summary of the qualitative replies.

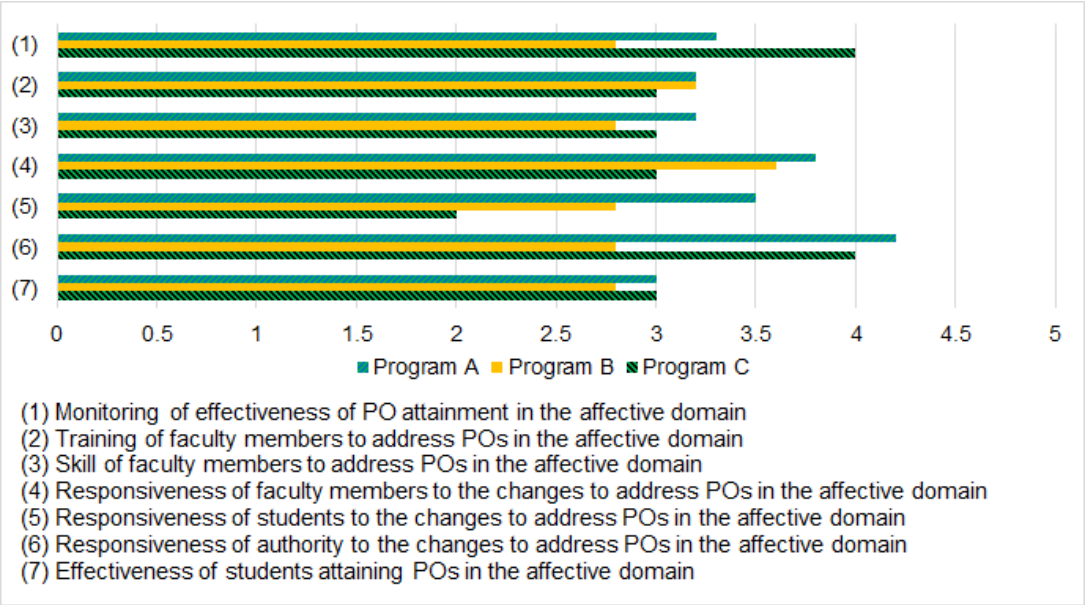

Figure 1: Mean values of the replies to the seven questions of the questionnaire which require numerical responses as per the 5-point Likert Scale

Table 2: Summary of the qualitative replies to the questionnaire

Questions	Program A	Program B	Program C
Most difficult PO to address in the affective domain	PO(f)	PO(h)	PO(f)
The assessment tool most used to evaluate attainment of POs in the affective domain	Rubrics	Viva-voce	Rubrics
Most used type of training	Training by internal resource persons	Training by external resource persons	Internal informal discussion
Changes made in the curriculum to address POs in the affective domain	New course and capstone project introduced	New course introduced. No capstone project	Capstone project and integrated design project both introduced
Changes made in teaching-learning to address POs in the affective domain	Affective domain activities introduced in capstone and other projects	Students were made aware of the changes in classes	Discussion sessions, group work, classroom debates, field visit introduced
Changes made in assessment to address POs in the affective domain	Rubrics introduced	Viva and presentation introduced	Rubrics introduced
Most difficult challenge to address POs in the affective domain	Lack of understanding and experience of faculty	Lack of understanding of faculty and students	Lack of training of faculty members
Unaddressed challenge to address POs in the affective domain	Effectively addressing non-technical outcomes	Use of rubrics in assessment	Training

Findings from FGDs

Important insights were gathered through the FGDs. The profile of the respondents and their levels of participation in the discussion revealed the extent of their involvement with the transformation process of the concerned program. In case of program A, all but one respondent were senior faculty members. Both the dean and the head were leading the transformation process from the front. On the other hand, for program B, the head was the only senior faculty member who was participating in the transformation. No professor from program B had any active involvement in the design or implementation of OBE. Only two faculty members responded from program C. One of them was a junior faculty member. Although the program has a number of senior professors including the head, none was involved in leading the transformation to OBE.

The major challenges to meaningful curriculum design and TLA in the affective domain as identified from the questionnaire response, FGD and curriculum review are as follows.

a. **Belief and commitment of the program leadership**: Most faculty members from all three programs underscored the importance of the commitment and support of the leadership towards the change. The Head of Program B, who was only recently appointed to the position soon after getting promoted to the position of associate professor, commented that unless the senior professors of the department felt and demonstrated some sort of ownership of the transformation, positive changes could not be impacted.

   It is known that active engagement and support of the program leadership (e.g., dean, head, senior professors) is very important (Radloff et al, 2008) for transformation. We also observe that such belief and commitment is demonstrated only in program A, which happens to be the only accredited program.

b. **Responsiveness of faculty members, students and authority**: While all respondents thought that the responsiveness of the faculty members and the authority were important, most did not feel that the responsiveness of the students was a critical issue. However, the Dean of Program A mentioned that unless faculty members, students and authority were all on-board, it was difficult to realize the desired changes. When all three are responsive and are collaborating, a synergetic effect takes place and transformation becomes more meaningful (Kolmos et al, 2016). This assertion is corroborated when we look at Figure 1. Faculty members, students and authority are all responsive only in program A. It may be mentioned that the results of Figure 1, in a few instances have contradicted the findings from the FGDs. For example, the response from program C to question 6 was quite positive. However, in the FGD, one respondent from program C expressed concern at the reluctance of the authority to allow the faculty members select assessment tools as they find appropriate.

c. **Lack of understanding of the faculty members**: Every participant in the FGDs has categorically mentioned that they were having difficulties in writing the COs in various courses in the affective domain and in defining the corresponding assessment rubrics. Respondents have also identified lack of understanding and training as the most difficult challenge in Table 2. Participants of Program B have identified in Table 2 that preparation of the assessment rubrics is the challenge which remained unresolved. However, for question (3) in Figure 1, average responses from both programs A and C have been positive. This is contradictory to the findings from FGDs. The Dean of program A shared that they had adopted an iterative approach involving most of the faculty members to overcome the CO writing difficulty. The articulated CO statements were collectively reviewed after each iteration and then revised until the statements turned out to be acceptable. Both the Dean and the Head agreed that this approach also helped to improve the understanding of the faculty members. On the other hand, the coordinator of Program C informed in the FGD that they had assigned the responsibility of writing CO statements of all courses to only a few select faculty members to accelerate the transformation. On the one hand, this method enabled the program to complete writing of the COs of all the courses within a reasonable time. But on the other hand, the majority of the faculty members remained unengaged in the process. Consequently, the enhancement of their CO writing skills was less than desirable. Respondents in the FGDs

with both programs B and C expressed concerns about their lack of opportunity to select suitable assessment tools. Both their institutions mandated that 70% of the course marks must come from written mid-term and final exams, leaving the faculty members with little or no freedom to select the assessment tools that they deemed appropriate. The Head of program B shared that the proposal from their department to allow the faculty members to choose appropriate assessment tools in their respective courses was turned down by the authority. Most respondents from all the programs felt that lack of useful training was responsible for their poor understanding of the process. According to the participants of program B, the training sessions that were organized for them focused more on accreditation and less on the relevant conceptions. One respondent from program C also blamed lack of interest of faculty members for poor understanding.

The study has revealed that lack of understanding to meaningfully write CO and conduct TLA in the affective domain is the most serious challenge. Lack of understanding comes from not having clear conceptions about the affective domain (Savickiene, 2010). Lack of belief and interest of the faculty members in the affective domain outcomes also contributes to the apparent lacking in understanding (Radloff et al, 2008).

d. **Capstone project**: All the respondents from all three programs have unequivocally expressed their beliefs in the importance of the capstone project. However, the ground level reality of the capstone project was different for all three programs. We were informed in the FGDs that the students of program A were doing comprehensive capstone projects that culminated all POs but PO(a). But the curricula of program B did not have any capstone project as such. Students of program C had just started doing capstone projects, but the respondents of program C acknowledged that their faculty members were struggling to meaningfully assess outcomes in the affective domain. Experience of this struggle was also shared by the faculty members of program A even though students of this program were required to do elaborate capstone projects. They expressed confusion about identifying appropriate assessment tools for the affective domain outcomes.

   Capstone projects are important learning tools which prepare the students for the practice of engineering (Dutson et al, 1997). Comprehensive capstone projects, when designed skillfully, can appropriately address POs in the affective domain. However, designing and implementing such capstone projects is non-trivial and this requires substantial expertise and experience.

Discussions

The respondents have indicated that lack of clear understanding of either the affective domain POs or the suitable ways to address the affective domain is the most difficult challenge. There are two closely related major reasons behind this challenge. First, the faculty members lack clear conceptions about the affective domain itself. Lack of interest and resistance to change also raise barriers against better understanding. Second, training on the conceptions and TLA in the affective domain is inadequate. Even though some programs have been conducting regular training sessions for faculty members on the OBE framework, TLA and accreditation, the affective domain mostly remains neglected. Not having enough resource persons with expertise in the affective domain concepts and TLA is partly responsible for this inadequacy. However, successfully addressing training inadequacy alone is unlikely to change the attitudes of those faculty members who lack interest or are resistant to change. These faculty members mostly subscribe to the content-focused traditional paradigm and changing their conceptions is not easy (Radloff et al, 2008). Furthermore, the challenges of responsiveness of the authority and the students to the changes are also only indirectly related to the affective domain-specific training.

The major challenges faced by the tertiary EEE programs in Bangladesh are also observed elsewhere. Although the underlying reasons are similar in many cases, different local contexts may make the solutions different. It is difficult to address the challenges in an ad hoc manner, since different issues (including those outside the scope of the affective domain) are interrelated,

one problem cannot be solved in isolation in a sustainable manner. The systems approach (Rompelman and de Graaff, 2006) is an effective way to transform the curriculum of an engineering education. Several studies have been reported in the literature on the implementation of the systems approach (e.g., Walkington, 2002). The systems approach considers all the challenges to the transformation in an integrated manner with a systems engineering perspective. It promotes collaboration and shared participation among the stakeholders and results in informed decision-making and sound management (Walkington, 2002). We argue that the most effective way to address the challenges related to the affective domain outcomes, as well as other challenges, in Bangladesh is to adapt to a systems approach. This further necessitates the commitment of both the institutional and the program leadership.

Conclusions

The challenges faced by the tertiary EEE programs in Bangladesh to address the affective domain have been studied. The major issues have been identified. These challenges are not unique. Similar challenges have also been observed in other countries. However, the solutions to these challenges would depend on local conditions and may be unique in many respects. A systems approach will help identify the specific challenges and opportunities around a particular institution or a program. Careful and methodical systems approach should be able to successfully transform the educational paradigm and the curriculum minimizing the adverse impacts of the challenges.

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Appendices

Appendix A: Program outcomes and knowledge profile as stipulated by BAETE

Program outcomes

a) Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization as specified in K1 to K4 respectively to the solution of complex engineering problems.

b) Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences. (K1 to K4)

c) Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations. (K5)

d) Conduct investigations of complex problems using research-based knowledge (K8) and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

e) Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering problems, with an understanding of the limitations. (K6)

f) Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems. (K7)

g) Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts. (K7)

h) Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice. (K7)

i) Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

j) Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k) Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l) Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

K1: Natural Sciences; K2: Mathematics; K3: Engineering Fundamentals; K4: Specialist Knowledge; K5: Engineering Design, K6: Engineering Practice, K7: Comprehension (ethics, professional responsibility to public safety; economic, social, cultural, environmental and sustainability); K8: Research Literature

Appendix B: Exploration questions discussed in FGD

1. The role the belief and commitment of the course instructors in the importance of affective domain POs play in meaningful attainment of these POs by the graduates.
2. The role the belief and commitment of the academic leaders (Deans/Heads/Coordinators/Senior professors) in the importance of affective domain POs play in meaningful attainment of these POs by the graduates.
3. The extent to which the strong emphasis of the previous input-based curriculum on technical topics has been retained after transformation to OBE paradigm.
4. The extent to which the course instructors are free to choose their assessment tools and the difficulty they face in exercising the freedom or the lack of it.
5. The extent to which the students should be knowledgeable about the OBE paradigm.
6. Whether relevant POs (f, g, h, i, l) are addressed by specific dedicated courses or whether these POs are embedded throughout the curriculum. Justification of the selected approach.
7. The importance of the capstone project in meaningfully addressing the POs in the affective domain.

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